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## BOMBARDMENT AND BURNING OF ALEXANDRIA.

THE Egyptian revolt, under Arabi Bey, against the government of Egypt by European powers in the interest of European creditors, has ended in war. As the party chiefly interested—through the ownership of the Suez Canal and otherwise—England has assumed the responsibility of "restoring order," and has proceeded in the usual way, by bombarding Alexandria, the chief commercial city of the country. The bombardment began at 7:45 on the morning of July 11. The attacking fleet comprised seven powerful ironclads and the gun-vessels Bittern, Condor, Beacon, Decoy, and Cygnet. The strength of the ironclads is shown in the following table:

| Vessel. | Inches armor. | Guns. | H. P. | Tons. |
|---|---|---|---|---|
| Inflexible | 16—24 | 4—81-ton | 8,000 | 11,406 |
| Superb | 10—12 | 4—25-ton | 7,430 | 8,700 |
| Monarch | 8—10 | 4—25-ton<br>2—6½-in | 7,842 | 8,322 |
| Sultan | 6—9 | 8—18-ton<br>4—12-ton | 8,629 | 9,286 |
| Alexandra | 8—12 | 2—25-ton<br>10—18-ton | 9,492 | 8,615 |
| Témémaire | 8—11 | 4—25-ton<br>4—18 ton | 7,700 | 8,540 |
| Invincible | 6—8 | 10—12-ton | 4,832 | 6,034 |
| Penelope | 5—6 | 10—12-ton | 4,702 | 4,394 |

The defenses consisted of forts and shore batteries, mounting for the most part guns of antiquated patterns, firing round shot only, and unskillfully handled. The Egyptians showed great stubbornness, but the weight of metal was overwhelmingly on the side of the fleet. The Inflexible did good work at ranges varying from 3,000 to 5,000 yards, shelling forts right and left from her two turrets. The Monarch fired 200 heavy shells and 6,000 pounds of shot from Gatlings and Nordenfelt machine guns.

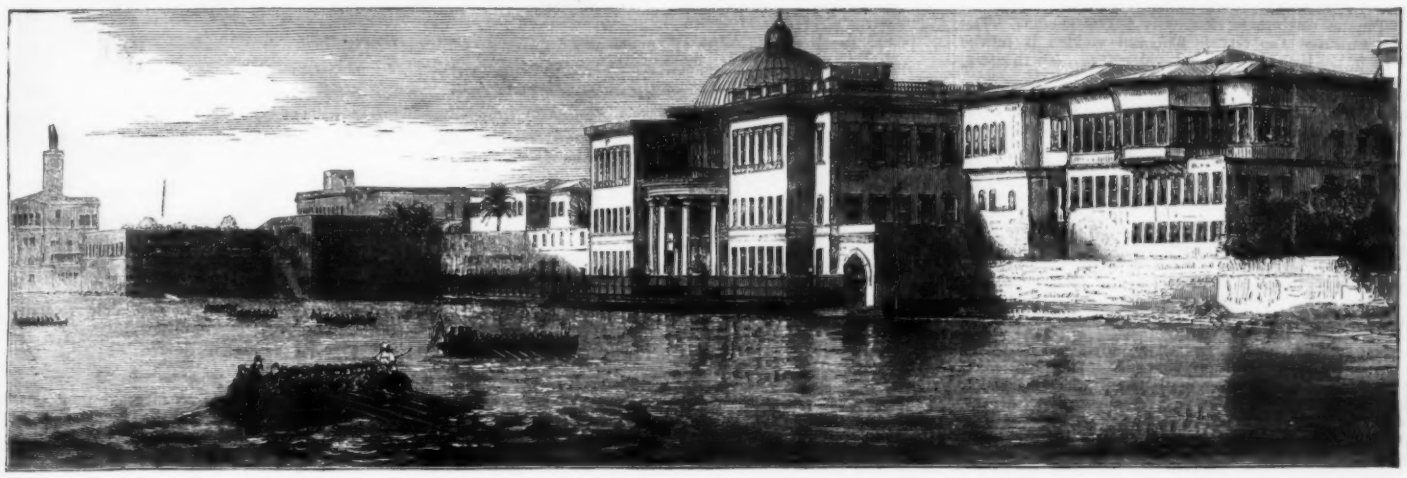
The effect of the electric broadsides fired from the Sultan and the Alexandra was very destructive, and excellent work was done by the gunboats. In the course of the forenoon nearly all the Egyptian guns were silenced and the forts badly battered. The loss of men by the English was slight, five killed and twenty-seven wounded. The Egyptian loss was apparently heavy. None of the ships was materially damaged; few were hit at all.

The next day (July 12) the sea was too rough to allow the fleet to do much execution; and at night the city was evacuated by Arabi Bey, after it had been given over to fire and pillage. The city had been much damaged by the shells of the fleet, and the natives retaliated by burning the European quarter, with a general massacre of the remaining Christians.

Nearly one-half of the city is now a mass of ruins, including all the splendid buildings around in the great square, shown in our engraving.

## THE CITY OF ALEXANDRIA.

PREVIOUS to the political disturbances which caused a general exodus of Europeans from Egypt and led up to the



THE RAS-EL-TIN PALACE AT ALEXANDRIA, EGYPT. THE RESIDENCE OF THE KHEDIVE.

THE GRAND SQUARE, ALEXANDRIA, EGYPT, RECENTLY BOMBARDED AND BURNED.

bombardment and practical destruction of Alexandria, the city had a population of about 215,000 inhabitants, nearly 50,000 of them Europeans.

The city lies on the Mediterranean, near the mouth of the westernmost arm of the delta of the Nile, and occupies a peninsula, anciently the island of Pharos, and the neck of land connecting it with the mainland.

On each side of the isthmus is a good harbor, that on the east being mainly artificial. Its excellent position for trade made it the chief commercial city of Egypt and the great central station for passengers east and west, the steamers to and from India, the Levant, and Western ports all stopping there. It is connected with Mansoora and the Suez Canal by railroad, and with Cairo by rail, canal, and river. In its newer portion Alexandria had the appearance of a European city. It was lighted with gas and supplied with water from the Nile. Besides its large export and import trade the city was the seat of large government and private manufactures run by steam. It had many fine residences. Among the prominent buildings were the palace of the Khedive at Ras-el-Tin, the large naval arsenal, the naval and military hospitals, the Custom House, Tribunal of Commerce, Italian College, and the various schools.

Alexandria was founded by Alexander the Great in 332 B.C. Under his successors, the Ptolemies, the city contained 300,000 free inhabitants and as many slaves. It became the center of learning, and schools of Grecian philosophy flourished there. Magnificent monuments were erected, among them the Pharos, the Museum, and the Temple of Serapis, and there were many gorgeous palaces and public buildings.

Julius Cæsar besieged and took the city in 48 B.C., and eighteen years later Augustus made it an imperial city. It now began a new season of prosperity, continuing till the establishment of the seat of empire at Constantinople. The Catacombs, public baths, and Pompey's Pillar, with the Roman city wall, were erected during this period. In the year 215 the Roman Emperor Caracalla visited the city and ordered a general massacre, and under the rule of Gallienus a famine swept off half of the population. In 273 an insurrection resulted in the destruction of the great library of the museum. In 296 another revolt ended in a general slaughter, and in 365 an earthquake destroyed 50,000 persons. The Persians captured the city in 616, and yielded it to the Arabs in 641. It then contained 400 palaces, 400 theaters, 4,000 public baths, and 12,000 gardens.

From this time on it rapidly decayed, and its population and trade diminished. Cairo took its place as the chief city of Egypt. It finally sank so low that in 1777 its population was only 6,000.

## THE BOMBARDMENT OF ALEXANDRIA ALLEGED TO BE HEARD 1,000 MILES.

For the first time in history the progress of a great naval engagement has been consecutively reported by telegraph. A novel member of the fleet before Alexandria was a telegraph ship, through which, by means of the Mediterranean cable line, the War Office in London and the civilized world were kept informed of the movements of the war vessels and the results of the firing.

The nearest cable station from Alexandria was at Malta, distant about 1,000 miles from the scene of the battle. A press dispatch says that when a telephone was attached to the Malta end of the cable the firing of the guns at Alexandria could be distinctly heard, though no oral communication was possible over that length of cable. It is not stated whether a telephone transmitter was used at the Alexandria end, or whether the general electrical disturbance, caused by the explosion of the great guns, so affected the cable as to report the shots, through the telephone, at Malta.

## THE KHEDIVE'S PALACE, ALEXANDRIA.

THIS building is situated on what was once the Island of Pharos, and is now a peninsula, joined by a narrow neck to the mainland. Here, also, is the Fort of Ras-el-Tin, the stronghold of Alexandria. The Khedive resided there, and the neck of land was covered by the guns of the combined squadron during the recent bombardment.

## THE GREAT SQUARE, ALEXANDRIA.

THE Place of Mehemet Ali, or, as it is better known by Europeans, the Great Square of Alexandria, was the chief scene of the native rising against the Europeans on Sunday, June 11, 1882. This large open square was the main center of the European quarter. There were situated the principal banks, houses of business, hotels, and cafes, and there, on festival days, the band played. Indeed were it not for the many-hued and strangely-shaped costumes, the spectator might fancy himself in some public garden in Paris or Vienna. During the riot terrible outrages were committed upon the Europeans, but we may state that the rising, though apparently provoked by an accidental quarrel between a Maltese and a donkey driver, was manifestly carefully planned beforehand. The quarrel alluded to took place in a side street, and when the Arabs ran up to assist their countryman, the Maltese took flight to the square. The mob followed, and at once began an unmerciful attack upon the Europeans, beating them over the head with bludgeons, and rushing into the cafes and pillaging the shops. For three hours the square and the adjoining streets were in possession of the mob, the police and soldiers standing idle, until at last a regiment was marched up in order and the rioters were dispersed. The number of European victims has been variously stated, but about 250 are thought to have been killed.

## THE SUEZ CANAL.

THE special hall of the Museum of the Marine—the Lesseps Hall—devoted to the history of the ship canal, contains some remarkable models of the powerful machines that we have described in a former article, such as dredges with long chutes, sand elevators, dry-earth excavators, etc.; all of which give a very accurate idea of the operations on the colossal work. Those of our readers who live in Paris will be enabled, then, to make completer descriptions than we have endeavored to render as clear and as short as possible, by going and making a short stay before the pygmy dredges, reduced with wonderful accuracy, which are seen at anchor on the sandy bottom of the trench, pouring the desert sand into a long chute that terminates at a hillock already raised on the bank. Under the elevators are seen the barges with their boxes filled with the excavated material; the dry-earth excavator is stretching its chain and buckets over the talus of the cutting, and the microscopic steam engine that actuates all this assemblage seems just ready to operate. To have made the illusion complete it would only have been necessary to average this mechanical toy in such a way that a simple stress exerted on the mechanism would cause a revolution of the chains and buckets and a rolling of the cars over their inclined plane.

Let us give life to each of these apparatus for a few moments, and we shall then faithfully re-establish the mode of work adopted for each of the great sections of the Isthmus Canal. If we cause the dredges and elevators to work, we shall have before our eyes the digging of the low parts of the desert, the marshes of Menzaleh, the approaches to Lake Timsah and Bitter Lake, and the plain of Suez. Let us set the excavator in operation, and we shall reproduce the installation of the great El Guisr cutting (Fig. 1), executed by Mr. Couvreux. On the slope that had been already worked by the preliminary labors of the Egyptian fellahs, are stationed the excavator and the motor that actuates the chain and the buckets. The material removed is poured uninterruptedly into trains of cars which carry it to the dumping station. The entire apparatus—motor and excavator—runs on rails, and may be shipped to other appropriate roadways when the progress of the work requires it. The operation

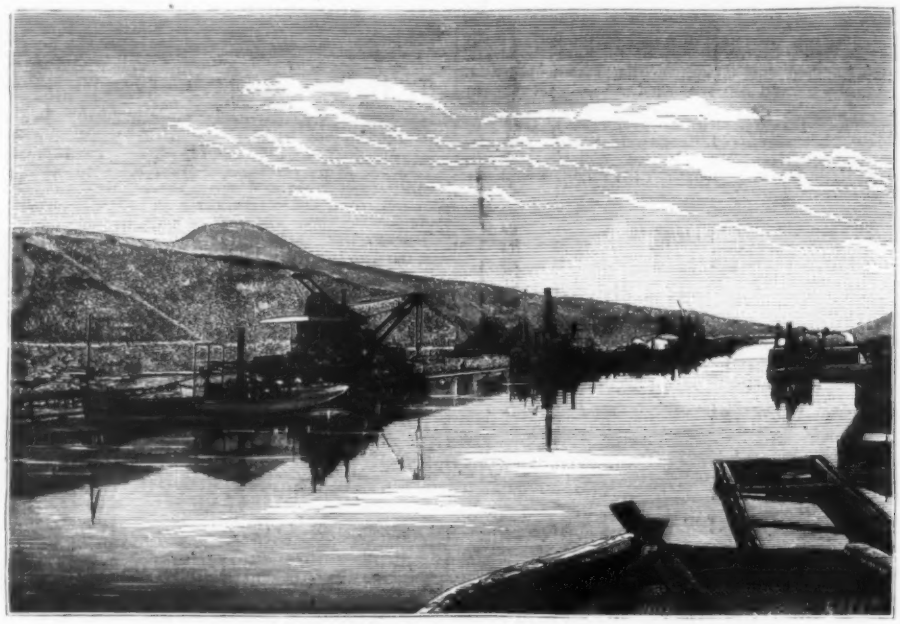


FIG. 1.—THE SUEZ CANAL.—THE COUVREUX EXCAVATOR IN THE GREAT EL GUISR CUTTING.

of the excavator, like that of the dredges that are to come after it to finish the submarine excavation, is certainly very easy to understand; and, in regard thereto, we have no need to enter into any mechanical details, as every reader will imagine without effort the progress made each day until the 4,500,000 cubic meters of the cutting were removed.

Besides the specimens of the machines the Museum of Marine possesses also a plan in relief of the entire Isthmus, prepared under the intelligent direction of Vice-Admiral Paris, the curator of the institution. An examination of this plan, which measures 10 meters in length, by 2·4 in width, and which is constructed on a scale of 0·06 of a meter to the kilometer, is nearly indispensable to those who wish to acquire a clear conception of the superficies of the Isthmus. While speaking of colossal work, of millions of cubic meters of clay or sand to be removed, it has all the time seemed to us that the reader might be led to form an erroneous idea of the work, and imagine it to be an imposing one, with high mountains to be cut through, and accompanied by natural obstacles that were almost insurmountable. But, as we have already said, the Suez Canal was far from presenting any such features of extraordinary difficulty.

When we see the present Port Said, with its admirable basins, its two gigantic jetties between which the steamers sail before entering the canal, we certainly find it difficult to imagine the beginning of this important town, when only twenty years ago, at that period of the work that has been called the "heroic," the encampments of the first workers, consisting of huts elevated on piles that were lashed by the waves of the Mediterranean, bore quite a resemblance to the lacustrine villages of prehistoric ages. In 1859 that corner of the desert waste which, ten years later, was to offer a splendid hospitality to the representatives of the entire world, contained twelve Europeans and one hundred fellahs! In 1860, the first shelters were erected; and in 1861 a few shovels and wheelbarrows were received. Fresh water—in the majority of cases brackish—came from Damietta in reservoirs; later, it was brought through Lake Menzaleh, cost sixteen francs per cubic meter, and was almost fought over on its arrival.

Finally, the first dredge, which was not at all comparable with the machines of the real period of the work, was dragged with great trouble, piece by piece, through the mud of Lake Menzaleh. Beginning with this epoch Port Said rose as if by magic.

Over the whole length of the arc of the circle that separates the Mediterranean from the marshes formerly watered by the now obliterated branches of the Nile, the choice of Port Said had not been left to chance. At first the thought had occurred to select the Bay of Peluse as the mouth of the future canal; but, in order to find in front of Peluse the depth of 8 meters, which was necessary both for the anchorage of ships and for the bottom of the channel, it was found that it would be necessary to go out to sea a distance of 7,500 meters from the shore. At Port Said it was only necessary to prolong the jetty 2,300 meters to accommodate the maritime service. This latter place was then selected, and, after some preliminary work, the two superb jetties that we now see stretched out like two immense arms, gradually began to show their luminous blocks of stone above the waves. Let us remark just here that Suez, unlike the Mediterranean port, has no jetties, the waters of the Gulf being sufficiently calm. At Suez the canal debouches between the quays of the town (Fig. 2).

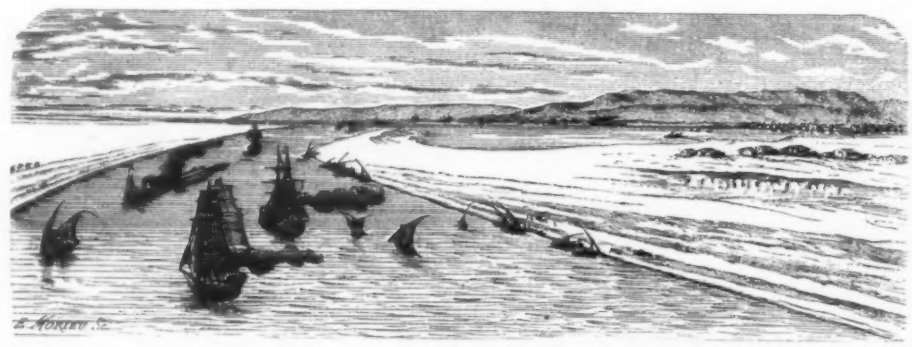


FIG. 2.—THE SUEZ CANAL IN THE PLAINS OF SUEZ.

The Isthmus is a tongue that may be considered as being on a level with the sea. The "hills" of the El Guisr, Serpeum, and Chaloof are scarcely discernible on the relief plan in the Museum, although the scale of heights has been exaggerated therein.

So, the glory of having finished the canal, and of having created a new route between two worlds by cutting through this bond of union of Africa and Asia, resides principally, not in the mechanical operation of removing the sand, however intelligently this was done, but in the general installation of the entire work, in the character of grandeur that M. de Lesseps infused into his enterprise, with sufficient confidence in its duration and prosperity to allow him to predict at Port Said the future of a new Venice. The founding of this new town of Port Said, and the finishing of the fresh water canal, which sets Ismailia free, vivifies the entire Isthmus, and afterward directs its waters toward the Red Sea and the Mediterranean, are two of the most interesting chapters in the history of the ship canal.

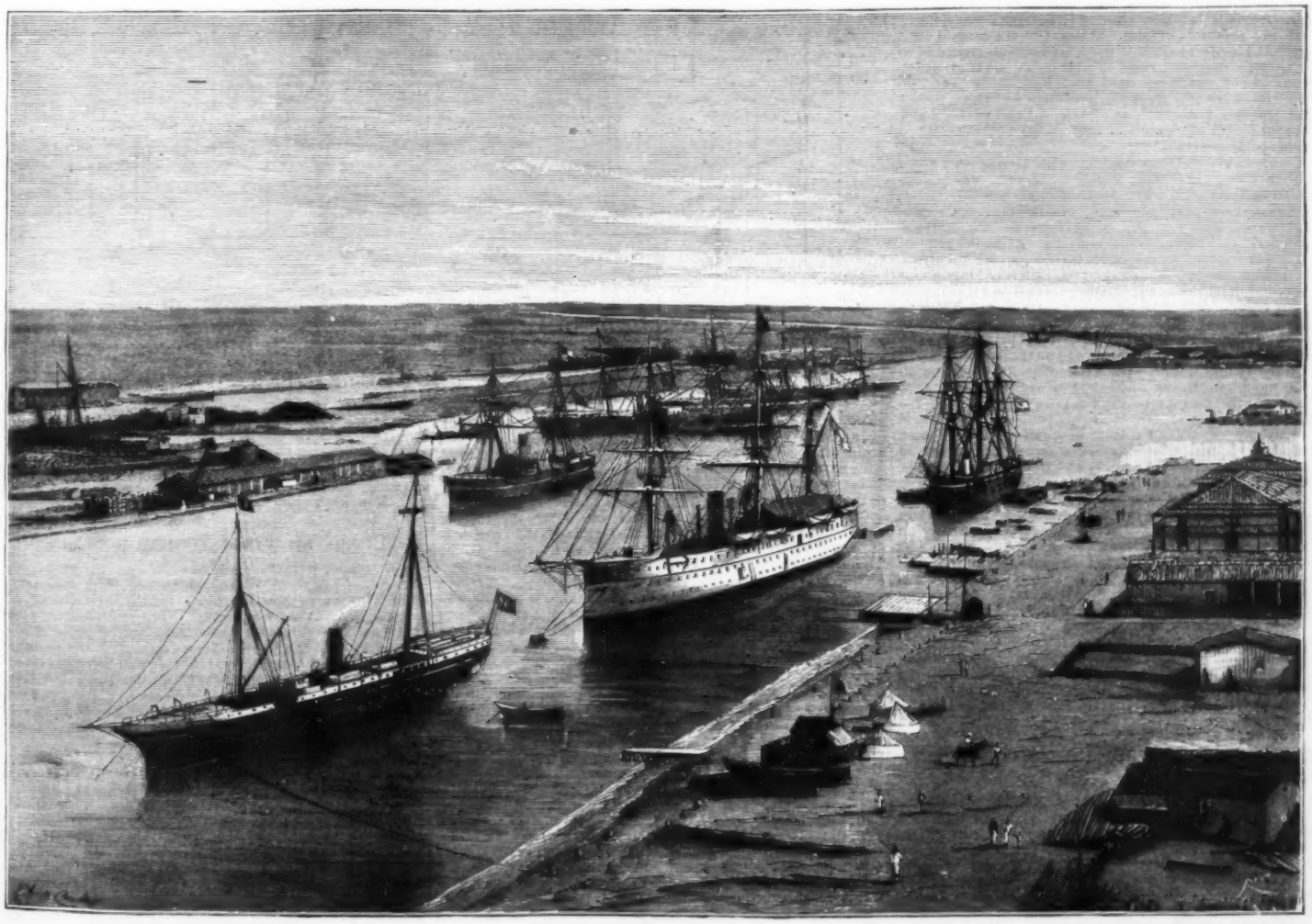
The construction of the Port Said jetties was one of the most curious works in the execution of the canal. They were formed by piling up blocks of stone 10 cubic meters in size, and each weighing 20,000 kilogrammes. These blocks, when brought to the place at which they were to be submerged, were rolled over inclined planes into the sea, or else lifted by cranes which afterward allowed them to drop. The talus of the jetty was thus formed with the inclination that the blocks of themselves assumed. It was not necessary to bring natural stone to Port Said, for the sand there, mixed with the lime from Ardeche, in the proportion of 325 kilogrammes of lime per cubic meter, furnished an artificial substitute. These two admirable pieces of work were constructed by Messrs. Dussaud Brothers, the Marseilles contractors, who had previously executed the works in the ports of Cherbourg, Marseilles, and Algiers.

Between Port Said and Suez, at an equal distance from the two seas, rises, on the banks of Lake Timsah, the third capital of the kingdom, conquered from the desert by M. de

FIG. 3.—PRESENT ASPECT OF THE SUEZ CANAL AT PORT SAID.

Lesseps—Ismailia, a town that gives life to the entire Isthmus. It is through its fresh water canal, deriving its supply from the Nile at Cairo, that the existence of the maritime canal is assured. The width of this canal is 17 meters, and it is capable of distributing daily from Cairo to Ismailia 330,000 cubic meters of water. At 4 kilometers from Ismailia, at Nefiche, it forks to supply Suez and Port Said—the former by a prolongation of the canal itself, and the latter by a double cast iron conduit, 80 kilometers in length, laid along the bank of the ship canal. This magnificent installation, during the progress of the work, supplied the 25,000 laborers who were scattered throughout the whole extent of the operations; to do which, in the beginning, it became necessary to collect a regular army of camels, two thousand in number, which traveled for water to a distance of 25 kilometers from Ismailia, and returned each carrying two sixty liter barrels of it. Before the establishment of this fresh water canal the water trains that supplied Suez occasioned an annual expense of 1,200,000 francs. To-day, Suez, as well as Port Said, is fully stocked, and, throughout the whole extent of the fresh water canal, the ancient valley of Gessen of the Hebrews is restored to fertility.

The importance of the fresh water canal could not, in our opinion, be better presented than by the striking comparison instituted by M. de Lesseps in the discourse that he delivered on the day on which the waters of the Nile first reached the banks of Lake Timsah: "It is seven years ago, in December, 1854," said he, "that I had to make the first exploration of the desert of the Isthmus. I required fifteen days for preparations; forty camels, twenty of which were



THE SUEZ CANAL.—VIEW NEAR PORT SAID ON THE MEDITERRANEAN.

for water; tents; provisions of every kind; men as escorts and servants; and the whole of this for four persons. Before reaching the place where we were to unite, we had consumed fifteen days and spent ten million francs. In January, 1862, three days ago, I left Cairo in a boat, and, after a trip of forty hours, landed a few steps from here, having spent only twenty francs."

This intelligent appreciation of the *role* of the fresh water canal by the creator of the Suez passage, may be extended so as to apply to the maritime canal itself. It is yet but a few years ago that exchanges between the Asiatic continent and the different countries of the globe were effected through the long route by the way of the Cape of Good Hope, or through that of Cape Horn, thus doubling the extreme end of Africa or of South America. From Bombay to Marseilles or Bordeaux, for example, the route by way of the Cape of Good Hope was not less than 5,650 leagues. To Havre it was reckoned 5,800 leagues; to London, Trieste, or Amsterdam, 5,950 leagues; and to New York, 6,200. Since the opening of the ship canal these distances have been greatly reduced. From Bombay to Marseilles, instead of 5,650 leagues it is now only 2,375, from Bombay to London 3,100 instead of 5,950; and from Bombay to New York 3,760 instead of 6,200. The route of the Indies is to-day a direct one, and the Old World no longer forms but one and the same commercial continent, whose vital center is on this desert waste of Suez.

During the year 1881, 2,727 ships, gauging 5,794,400 tons, passed through the canal. From year to year the progression becomes more striking, for in 1880 there passed only 2,026 ships, with 4,344,400 tons, and, in 1879, 1,477 ships, with 3,237,000 tons. To repeat what we said in the beginning, this new river "flows with gold;" and it could not be otherwise with a work which, by shortening distances, gave a new impulse to the commercial life of nations in reducing the elements of traffic to the strictest economy. From Bombay or Shanghai to Marseilles and London, freight to-day is not over three pounds sterling per ton, while from Melbourne to the same ports the charge is four pounds. Can navigation by sail around the Capes be sustained in competition with the rapid route by the canal, even if the same conditions be imposed? The route through the Isthmus will hereafter have no rival; and this canal, which, according to the lugubrious predictions during its earlier days, was so soon to be filled up by the desert sands, M. de Lesseps is thinking about widening. The indefatigable maker has recently been at Alexandria again to inaugurate this new phase in the history of the ship canal.

Outside of the works that may be called prehistoric, which were executed on the Isthmus by the ancients—by the Pharaoh Nechos, by the Ptolemies, and by the Caliphs—the history of the piercing of the Isthmus of Suez, before the adoption of the definite project of M. de Lesseps, is long and instructive. During the course of his Egyptian expedition, Bonaparte recognized the ancient Egyptian canal, and formed a project of opening it anew from Cairo to Suez. He commissioned the engineer Lepère to take the levels of the Isthmus, but, as we have before stated, the latter found a difference of level of nearly 10 meters between the two seas. Moreover, as the conqueror was going to have other cares than the establishment of an entirely peaceful route, the project was given up by him. In 1840 M. Linant, of Bellefonds; in 1846, Enfantin; in 1847, M. Talabot; and then M. Barrault proposed different projects. During the course of the studies of the Talabot project the levelings of M. Bourdaloue made known for the first time that the level of the two seas was the same, thus confirming the assertions of Laplace and Fourier.

It would be unjust not to name also, along with M. de Lesseps, two men who, in absolutely different ways, have merited the gratitude of the public—Mohamed Said and Waghorn. The first named is the Khedive who accorded to M. de Lesseps the concession of the canal, without which the work could not have been undertaken. During the course of the work this Egyptian sovereign had many a time to fight English influence, which was hostile to the canal, and the judgment of which at that epoch was reflected in the words of Palmerston.

Waghorn is the English captain who, during the seven years from 1829 to 1837, fought against opinion with an unexampled tenacity. In order to show that, even overland, amid numerous natural obstacles, the Isthmus route was still preferable, as to rapidity, to that of the Cape, Waghorn carried, on Arabian boats and the backs of camels, duplicates of letters that had been forwarded by the Cape of Good Hope route. It was as a consequence of material proofs accumulated thus by Waghorn, that the Peninsular Company organized its first line of steamers on the Red Sea, and that a line of diligences was established from Suez to Cairo, the Isthmus route being created in principle. The name of the Khedive has been bestowed on the Mediterranean port of the Isthmus, and, with a consideration replete with delicate modesty, M. de Lesseps has desired that a bust of Waghorn, the pioneer of the Isthmus, be set up on the quay at Suez.

This tribute of gratitude and admiration having been paid to the two men whose studies or power had aided in the accomplishment of his work, and the last piece of fire works of the inauguration fêtes having been extinguished, any one else than M. de Lesseps would have rested on his well-earned laurels. But the daring traveler was already revolving in his mind the project of piercing the American isthmus.

Ten years later, we shall find the creator of the first maritime canal traveling over the swampy plains of Panama, as he did formerly over the desert of Suez; crossing the defiles of the isthmus; ordering soundings; marking the first track of the new transoceanic route; convoking at Paris a congress of engineers and savants; indefatigable; full of hope in the final success of his work; busying himself with measures, conferences, and voyages; surmounting difficulties of all sorts—diplomatic, technical, and financial; and thus obeying the proud device that he has adopted—*Aperire terram gentibus.—La Nature.*

## THE JEANNETTE EXPEDITION.—A CORRECTION.

*To the Editor of the Scientific American:*

In the issue of your valuable paper, No. 339, dated July 1, 1882, you published what purports to be an interview between Lieut. Danenhower and a correspondent of the London *Graphic*, in which it is stated that Lieut. Danenhower commanded the boat of the illfated steamer Jeannette that reached shore in safety, and in which the present survivors were saved. Such is not the case. Lieut. Danenhower was incapacitated for duty on account of the loss of his eyesight, and Lieut. Comdr. De Long placed Chief Engineer Melville in command of said boat, and to him alone is due the credit of bringing her ashore in safety and saving the lives of the crew and officers belonging to her. I hope you will correct the mistake for the sake of doing justice to that brave officer, Chief Engineer Melville, who, after rescuing those placed under his command, remained in the Arctic regions exposed to that deadly climate so many months searching for his lost shipmates.

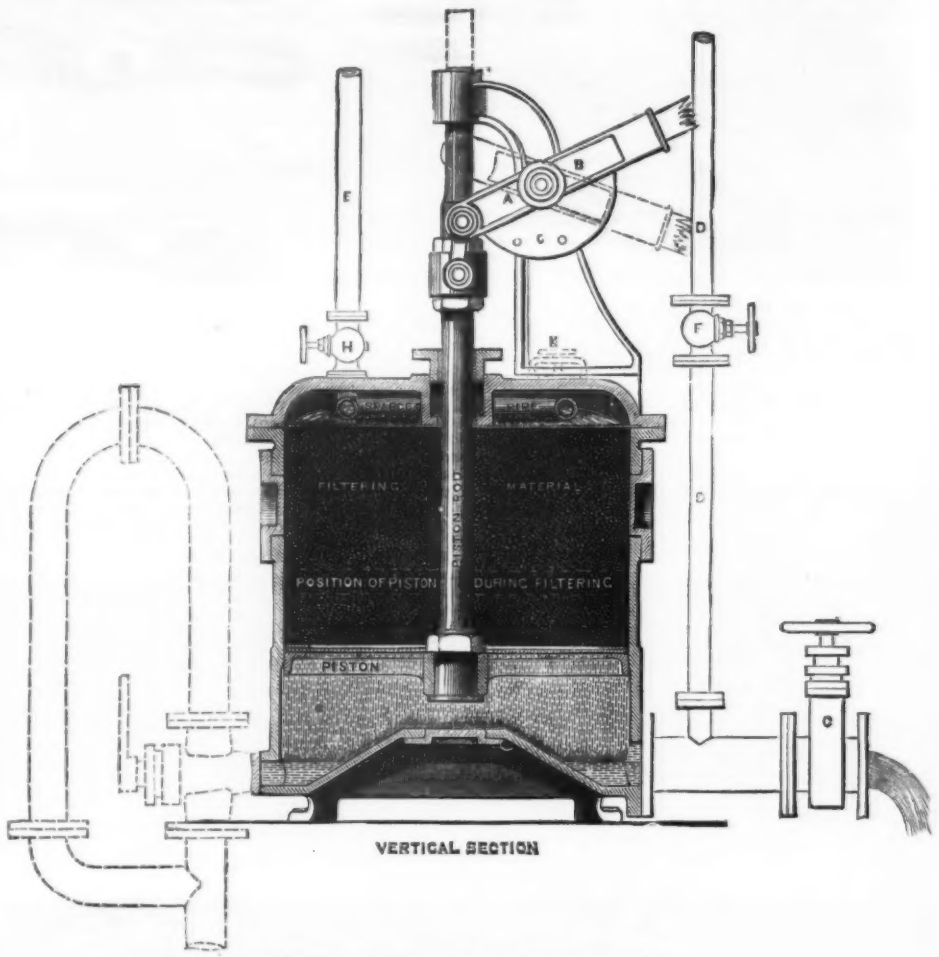
JUSTICE.

San Francisco, Cal., July 10, 1882.

## IMPROVED SPONGE FILTER.

THERE are many situations whereat it is necessary to use water containing considerable quantities of solids in mechanical suspension because no other can be obtained except at great cost. This is the case with many riverside mill owners, owners of tugs and other vessels employed in the lower reaches of tidal rivers and in harbors, and with the proprietors of baths. The result of the use of such waters is a much more rapid deterioration of boilers than would take place with clean water; in paper mills it causes much inconvenience and cost for filtering, and in tugs and similar steam vessels it not only causes the more rapid wear of boilers, but the vessels have to lie by at frequent intervals for boiler cleaning. A filter that will efficiently remove the suspended matter from such waters has thus long been a requirement, and several attempts have been made to construct one. Filters containing close woven cloth as a filtering medium have been made, but the trouble attending the removal of the deposit or mud from these cloths when filtering very muddy water has been found too great, and attended by so much labor and cost, that filters so constructed, even when arranged to be cleaned by reverse currents of water, have not given continued satisfaction. To overcome these objections the Pulsometer Engineering Company has returned to the use of sponge. Every one knows that as against mechanically suspended solids a pressed sponge makes a good and rapid filter. Like any other material, it becomes choked with mud more or less quickly, according to the quantity of water passed through it in a given time. Owing, however, to the expansive power of the sponge when relieved of pressure, it offers a filtering material which can be rapidly cleaned under alternate compression and relief in presence of water. For this then the means are provided in the Thames filter, as it is called by the makers, one arrangement of which is shown in the accompanying section, from which the general arrangement may be gathered. It will be seen that the filter consists of a cast iron cylindrical copper-lined vessel in which is placed a perforated diaphragm which has the motion of a piston given to it when it is necessary to clean the sponge. When ready for filtering, this diaphragm is raised by the piston rod and lever, A B, and the sponge between it and the perforated or gauze diaphragm in the upper part of the vessel is compressed. In this position it remains fixed during filtering by a pin in quadrant, C, which engages with the lever, A B. The dirty water passes down the pipe, D, up and through the filter, and issues clean into the pipe, E. To clean the filter the valve, F, admitting the dirty water, is closed, and the valve, G, is opened. The air valve, K, is also opened. The lever, A B, is now moved up and down, which causes the piston to alternately compress and allow the expansion of the filtering material. The clean water returning through the pipe, E, and valve, H, enters the upper part of the vessel through the sponge pipe, and washes the mud out of the filter through the valve, G. This valve is closed during filtering, and the F closed during cleansing. In many cases it is preferable to adopt the form of wash-out pipe, shown by dotted lines, so as to keep the filter full while cleansing. In very large filters the piston rod has a reciprocating movement given to it by an attached steam engine or by other source of power. The pipe, E, shown as conveying clear water from the filtered water tank to wash the filtering material, serves also to convey the filtered water from the filter to a tank or elsewhere, and it usually has an elevation of at least 10 ft. given to it so as to secure a head for washing out. The sponge employed is in small pieces, and the cost for renewal is small, the sponge being supplied at about 4d. per lb., the cost per annum being quite nominal. One of the filters of about 2 ft. in diameter we recently saw deliver 127·3 gallons in fifteen minutes into a tank arranged as above described, or at the rate of about 500 gallons per hour, which will be allowed to be a high speed. At this speed the filter removed every trace of turbidity, the effluent being bright, but to say that we have seen this filter remove all turbidity from very turbid Thames water taken in at Nine Elms, is only to say what every one can see would be the result of the arrangement of the filter and the use of compressed sponge as a filtering medium. It is not, of course, proposed that this filter will render turbid water having deleterious constituents fit for drinking, or what would be called for such purposes perfectly bright, but that it removes all traces of suspended solids at a great speed, so that very large quantities as required for boilers, paper mills, and other manufacturing purposes may be filtered, and so prevent the losses and trouble which follow the use of turbid water. This it does most successfully, and when the sponge is clogged the operation of cleaning in the size above referred to is done in a few minutes by one man.

Among others who are using these filters, Messrs. Coles, Shadbolt & Co., of the Thornhill Wharf, Caledonian Road, whose boilers are supplied from the Regent's Canal, find that their boilers which are 36 ft. in length, may run two months and be almost clean at the end of that time, while previously the boilers were constantly cracking and requiring costly repairs, as well as constant cleaning. The smaller sizes of filters are being employed on river boats of various kinds at home and abroad, but larger sizes up to 4 ft. in diameter are made for manufacturing purposes, and where large numbers of boilers are in use.—*The Engineer.*




VERTICAL SECTION

IMPROVED SPONGE FILTER.

## IMPROVED WINDING GEAR FOR MINES.

IMPORTANT improvements have lately been introduced by Mr. John Craven, of Wakefield, in the form and arrangement of winding gear for mines, for the invention of which letters patent have been granted. The improvements consist mainly in obviating the necessity for coiling ropes round the drums usually employed, and so removing the danger and expense arising from the great wear and frequent injury of the ropes by one coil chafing against the other. In order to effect these objects, the inventor employs a single winding rope, an upper set of grooved headgear pulleys, and a lower set of grooved winding pulleys, each consisting of two pulleys and an intermediate grooved pulley between the two sets. The rope is attached at one end to one of the cages, passes over one of the headgear pulleys, under one of the winding pulleys (to which the motive power is applied), and back over the intermediate pulley, and then under the other winding pulley, and thence over the other headgear to the other cage, to which the end of the rope is attached. This arrangement is designed to give greater durability to the rope, and to obviate all tendency to slipping of the rope, as in proportion as the weight of the load is increased the adhesion of the rope is augmented. The bearings of the intermediate pulley may be carried in a movable frame, either inclined or otherwise, so as to admit of the pulley being adjusted as required, in order to maintain the rope taut.

Fig. 1 represents in elevation and Fig. 2 in plan, a winding

gear constructed and arranged after the method above described. A set of two grooved headgear pulleys is mounted in bearings on the headgear or framework, and another set of two grooved winding pulleys is keyed on the crank shaft of the engines in the engine house. The headgear pulleys are preferably set at an inclination inward toward the winding pulleys in the engine-house, as shown in the plan. The intermediate grooved pulley is mounted in bearings carried by the framework. The single winding rope is attached at one end to one of the two cages, and passes over one of the headgear pulleys, thence under one of the winding pulleys in the engine house, and then back and over the intermediate pulley, and then under the other winding pulley in the engine house, and to and over the other headgear pulley to the other cage, to which the end of the rope is attached. The winding engine is represented in the engraving, and its power is applied to the cranked shaft of the engines, on which the winding pulleys are mounted, so as to drive the

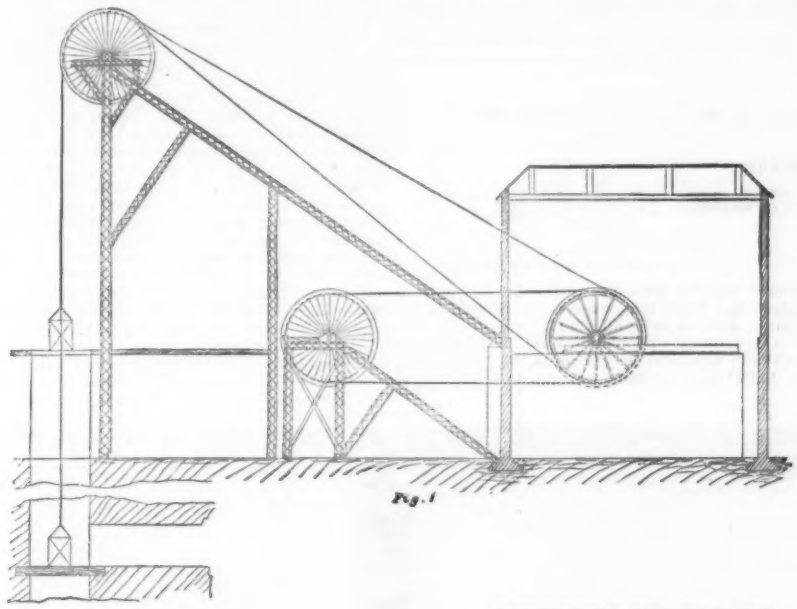


Fig. 1

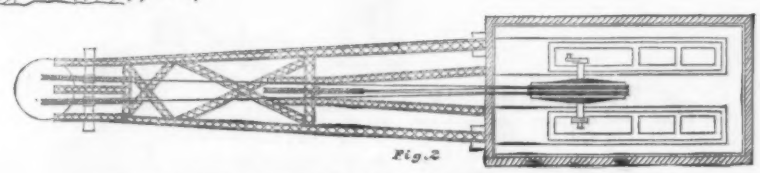


Fig. 2

## IMPROVED WINDING GEAR FOR MINES.

pulleys in the one or the other direction for raising the one cage and lowering the other by the one rope. The bearings of the intermediate pulley are in blocks, which are capable of sliding upon guides carried by the framework. To these blocks are attached the rods represented in the elevation, the other ends of which are screwed and pass through lugs, and are provided with screw nuts. By screwing up or slackening these nuts the bearings can be moved in one or the other direction to maintain the rope taut, or to slacken or tighten it as required. The following specific advantages are claimed for the invention: No chafing of rope as in the ordinary system of drum, so that the ropes last longer; reduction of work for the engine to do in starting; reduction of strain upon the engine, etc., in stopping; speed, instead of being obtained by a large diameter of drum, is got from the engine running quickly; a smaller engine is required than with ordinary gear, owing to the comparative lightness of the winding pulley; the winding pulleys have only one groove each, and are of very small weight comparatively; saving in first cost, the engine-house being much narrower, and only one rope required instead of two; great adhesion, no slip occurring between the rope and the pulleys.—*Colliery Guardian.*

## LOGGING IN CALIFORNIA.

MOST of the timber is now felled with saws instead of axes, as hitherto, it being found that the tree jumps better from the stump, and causes less waste by breakage, than where the ax is used. The trees are then barked, and a fire run over the ground to burn up the bark and rubbish. Green redwood burns with such difficulty that the good logs are rarely affected by the fire. And now, when all that will burn has been consumed, begins the real labor of getting out the logs. For handling these monsters no ordinary road will answer. It must be wide and smooth as a turnpike, all rocks and roots must be carefully removed, all hollows and gullies filled up; if the road is level or soft, skids must be laid down. If the logs are small, of course such care need not be taken, but for large timber it requires good engineering and much hard work even to build a good logging road.

With the road built, comes the labor of rolling the logs into it. Cattle alone would be useless, except for the smaller logs. Blocks and tackle, often double, and sometimes triple blocks, are needed to roll them out of their beds. Nor will any ordinary teamster answer to handle the cattle. He must be a man of judgment and skill. The best teamsters command a salary of from $100 to $150 per month and board. The "bull whacker" is usually the highest priced man in the camp.

Once in the road, several logs are fastened together to make a "train," and are hauled to a landing to be loaded on to cars, or to the stream to be floated to the mill. The train of logs once started, there must be no stopping if it can be avoided. All along the road are stationed barrels of water. As the train moves, a man runs along beside it, and, filling and refilling his pail from the barrels, throws water in front of the train, that there may be as little friction as possible. The loads hauled are sometimes enormous. One train of seven logs, hauled on Humboldt bay in 1878, by A. A. Marks, teamster, with five yoke of oxen, scaled, collectively, 22,500 feet, board measure, of merchantable lumber. No wagons are used in the woods; the logs are simply "snaked" on the ground.

Until within the last year, all this labor of handling logs in the woods has been done with cattle, but now they are in many places using steam for this purpose. The machine used is "Dolbeer's Patent Steam Logging Machine." It consists of an upright boiler and engine, somewhat similar to a portable hoisting engine, except that instead of a reel to wind the rope on, it has two "gypsy heads," one on each end of the reel shaft. It sits on a strong frame, the sides of which are like sled runners. It has a strong purchase from the engine to the "gypsy" shaft. To move the machine around in the woods, they run a line ahead, make it fast to a tree or stump, take two or three turns around the "gypsy," and start up the engine. In this way it hauls itself wherever wanted. When the machine is in place, it is made fast to a tree or stump, and a line run to the log to be moved, and by means of snatch-blocks the log is hauled in any direction desired. By use of this machine heavy logs are brought out of ravines and bad places, where it would be almost impossible to get them with oxen or horses. The wooden railroad, or tramway, is used in many places for transporting the logs to the streams, or to the mills, but as the more accessible timber is being cut off, these are being supplanted by iron and steel rails and locomotives.

Our redwood mills are generally up to the times. All the modern improvements of double circulars, gang saws, pony saws, gang edgers and trimmers, are in use. While double circulars are used in nearly all the redwood mills, many mills on Humboldt bay are using, besides, what is called "Evans' third saw." This is a saw hung on a horizontal arbor above the double circulars, and cuts down from the top of the log to a little below the arbor of the middle saw. While, of course, it is parallel to the two lower saws, its cut is made four inches out further into the log. Besides this saw, there is a fourth smaller saw, which is hung on a perpendicular arbor, and makes a horizontal cut into the log just at the bottom of the cut made by the third saw. The effect of running these two saws is to rabbet out a piece, extending from the top of the log to a little below the arbor of the middle saw. These three larger saws are usually from 60 to 64 inches diameter, and mills thus arranged can cut logs eight feet in diameter. Logs larger than that must be split.

There are about 40 mills engaged in cutting redwood. The largest have a capacity of 75,000 or 80,000 feet per day. Perhaps the average would be about 40,000 feet daily.

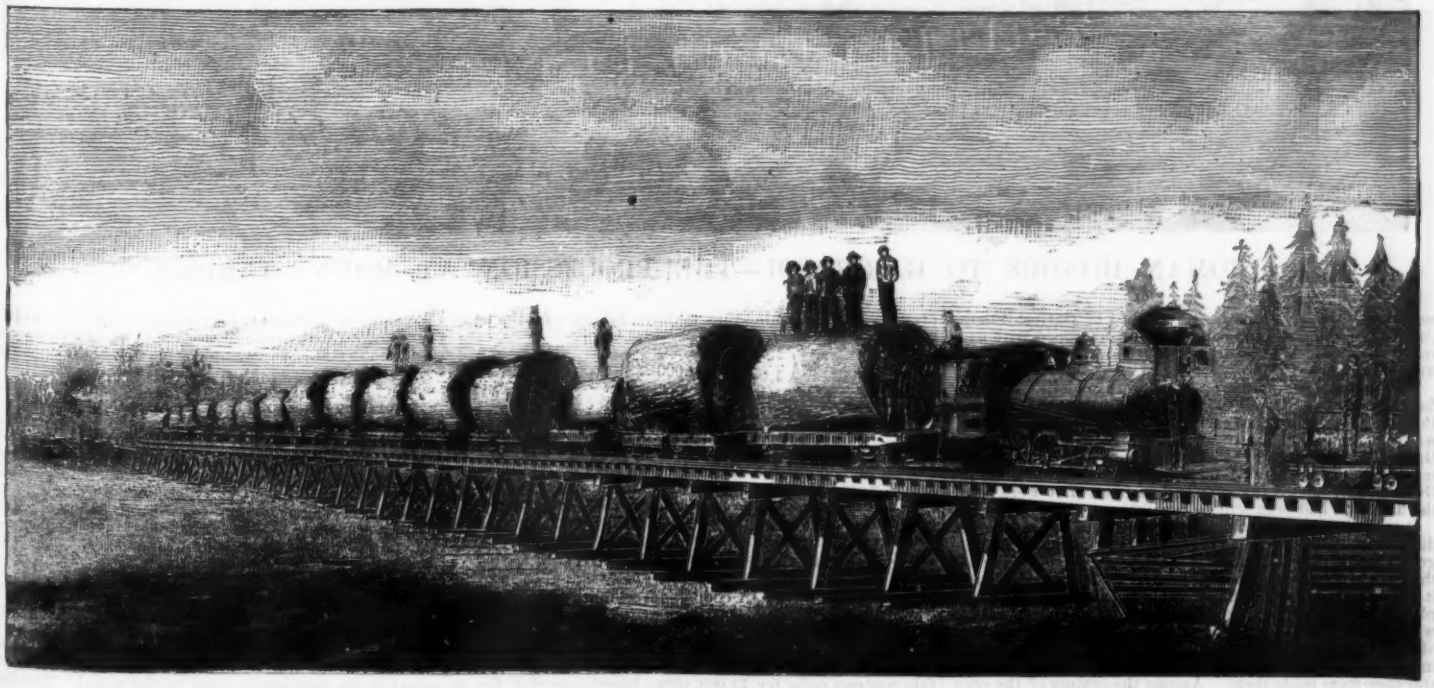
But very few, however, run all the year round, both on account of the difficulty of keeping supplied with logs, and because the places where many of them are situated are not safe harbors for shipping in winter. As very few of the mills are connected with the market by rail, nearly all the lumber is transported by sail vessels.

The amount of redwood lumber sawed by these mills in 1881 was not far from 140,000,000 feet. Of this, 95,000,000 came to the port of San Francisco, 4,500,000 feet being reshipped to New York and foreign ports. The balance of 45,000,000 feet manufactured was distributed to the lower ports in California, Mexico, South America, Sandwich Islands, Society Islands and Australia, vessels going direct from the mills.—*N. W. Lumberman.*

## A FORGOTTEN EVOLUTIONIST.

THE *Revue Scientifique* reproduces from the *Archives des Sciences Physiques et Naturelles*, an interesting paper by the distinguished Swiss botanist, M. A. De Candolle, in which the latter pays a fit tribute to the memory of the late Charles Darwin. In this paper, M. De Candolle calls the reader's attention to a long forgotten evolutionist, whose name and works he made known to Mr. Darwin in 1880. This old author was Duchesne, whose "Natural History of Strawberries" was published in 1766, many years before the appearance of those works of Lamarck which have caused the latter to be regarded as the foremost originator of the theory of the variation of species.

Duchesne, says M. De Candolle, "in no wise resembled Diderot, who, it has recently been discovered, held analogous ideas. Every man of ideas can plunge into hypo-



TRAIN OF CARS LOADED WITH REDWOOD LOGS.—FROM A PHOTOGRAPH TAKEN ON THE LINE OF THE HUMBOLDT LOGGING RAILWAY, IN HUMBOLDT COUNTY, CAL.

theses; but this does not count in science, for theories must rise slowly and laboriously from facts. . . ." The author of the "History of Strawberries" "was a horticulturist and a professor of natural history. His instruction was as varied as solid. The following is the observation of his which is sometimes cited without remarking the originality of the consequences that he deduced therefrom. Having sown some seeds of the wild wood strawberry that he had collected around Versailles, he saw, to his great surprise, that the majority of the plants obtained had but a single leaflet, instead of the three that are ordinarily characteristic of the species. He sowed the seeds of these singular individuals, and these gave the same form, which has since been preserved. Botanists name this new strawberry *Fragaria monophylla*. Duchesne started from this fact, and others that he had observed, to reason very profoundly on more or less hereditary new forms, and on what may be called species, race, or variety. He estimates that many of the forms designated as species are races, whose origin may be ascertained or at least presumed, and he allows words to drop from his pen that were truly extraordinary for the epoch. Thus, in speaking of the classification of species, genera, and families, he says:

"'A genealogical order is the only one that nature indicates, the only one that fully satisfies the mind; all other is arbitrary and void of ideas.'

"He even ventures to give a genealogical tree for the strawberry, constructed according to such pedigrees as he knew or presumed. This is what ultra-Darwinians are now doing, with the difference that Duchesne had ascertained one of the pedigrees, while they *suppose* them all from hypothetical views or from reasonings that are more or less debatable. No one paid any attention to the ideas emitted by Duchesne, and to such a point that a conscientious biographer, who pronounced a eulogy over him in public, omitted them entirely."

## ROMAN HONORS TO GARIBALDI.

ON the 11th of June, Rome presented a most animated scene. On the Corso and in all the streets through which was to pass the *cortége* carrying the bust of Garibaldi to the Capitol, the windows and balconies were festooned with flags veiled in crape. It is hardly necessary to say that the crowd was enormous.

The *cortége*, composed of numerous societies carrying flags and crowns, started at four o'clock from the Plaza di Popolo. The triumphal car, drawn by eight white horses, was surmounted by a statue of Liberty crowning the bust of Garibaldi. Some forty banners, on each of which was inscribed the name of a victory that had been won by the General, surrounded the car; and, in front of it were borne the flags that had been sent by the different cities of Italy.

It took the procession nearly three hours to traverse the distance that separates the Plaza from the Capitol. Our engraving represents it at the moment when, having traversed the Roman Forum and passed the Arch of Septimus Severus, it is beginning the ascent of Mount Tarpeia to reach the plaza of the Capitol. From the tops of the three palaces which inclose this beautiful plaza there floated the banners of the fourteen quarters of Rome. The car having stopped in front of the equestrian statue of Marcus Aurelius, several speeches were made there. Among the orators of the occasion we may cite Bovio and Songeon, the latter the President of the Municipal Council of Paris. The speech-making ended, Garibaldian officers in uniform removed the bust from the car and carried it up to the Capitol amid the applause of the assemblage, while the large bell of the Capitol tower pealed forth, and all the bands present played the "Hymn to Garibaldi."—*L'Illustration.*

## POPULATION OF THE EARTH.

A CORRESPONDENT (Mr. H. Percival) sends us the following question:

The land surface of the earth comprises 52,000,000 square miles. The most densely populated region (East Flanders) has a population of about 700 to the square mile. If the whole land surface of the earth were on the average as densely peopled, the earth's population would be 36,400,000,000. Assuming the present population to be 1,500,000,000, and supposing it henceforth to increase at the rate of 1¼ per cent. per annum, how many years would elapse before the earth's population would reach this number—*i. e.*, 700 to the square mile of land?

The population increasing in the ratio of 1,015 to 1,000 each year, if $n$ be the required number of years, we have the following relation:

$$(1{,}500{,}000{,}000)\left(\frac{1{,}015}{1{,}000}\right)^n = 36{,}400{,}000{,}000$$

$$\text{or } 15\,(1{\cdot}015)^n = 364$$

Taking logarithms of both sides, we have—

$$n \log.\,(1{\cdot}015) = \log.\,364 - \log.\,15$$

$$\text{or } n\,(0{\cdot}0064660) = 2{\cdot}5611014 - 1{\cdot}1760913$$

$$n = \frac{13{,}850{,}101}{64{,}660} = 214{\cdot}1 \text{ years very nearly.}$$

Here is another curious question: Supposing the population of England and Wales to increase at the rate of 1¼ per cent. per annum, and not to be affected by emigration, how long would it be before the population would increase from 26,000,000 till there would be one person to the square yard, or, roughly, 10,000 times as many persons as there are at present? To determine this, we have, taking $n$ for the number of years:

$$\left(\frac{1{,}015}{1{,}000}\right)^n = 10{,}000$$

$$\text{Or,} \quad n \log.\,(1{\cdot}015) = 4$$

$$\text{Whence} \quad n = \frac{4{,}000{,}000}{6{,}466} = 619 \text{ years nearly.}$$

So that, apart from emigration, war, plague, pestilence, or famine, the population of England and Wales, six centuries hence, would be one to the square yard.

In a quarter of the above time, say in 154 years, the population of England, apart from such causes, would be ten times as great as at present, or there would be about 4,500, instead of 450 to the square mile.—*Knowledge.*

A BARREL BOOM.—A cooperage establishment at Green Bay, Wis., is having a boom. It manufactures, for the most part, tripe, fish, pickle, and sirup barrels, and is not only selling all it can turn out, but it is so far behind orders that it recently refused an order for 10,000 barrels. A Buffalo contract calls for 13,000 sirup barrels, another for 19 car loads of pickle barrels, and a third large order is for white ash tripe barrels.

## TELEPHONIC INDICATOR OF THE TORSION AND THE SPEED OF REVOLUTION OF THE MOVING AXLE OF MACHINES.

By M. C. RESIO.

IN a memoir presented to the Academy of Sciences, March 15, 1880, I gave the description of a mechanical arrangement which, if fitted to the moving shaft of machines, measured its torsion by means of the telephone. But for this procedure two persons were required—one at the telephone, who would have to take his post at a considerable distance from the machine, the noise of which would hinder him from hearing the sounds of the telephone; the other very near to the shafting, who would have to displace one of the coils until the sounds of the telephone were extinguished, and measure the displacement required for this purpose in order to calculate the torsion. The process, besides, was applicable only to machines whose moving axle is of considerable length.

I have devised a new arrangement which can be applied to any machine whatever by a suitable modification of the transmitter, and in which a single observer placed at any distance from the machine may measure the torsion and the angular speed by the moving shaft, and consequently the work of the machine. The apparatus is composed of two parts, connected together by the electric current. One part applied to the shaft forms the transmitter, while the other, which may be placed anywhere, is the receiver. The principle on which it is based is as follows: If in a circuit containing a battery and a current interrupter capable of giving a sound there are two identical coils, arranged in tension, the one turned to the right and the other to the left, the induction currents, excited in two other (induced) coils, alike in all points and connected in tension in a circuit containing a telephone, destroy each other, and consequently the telephone will be mute if they are equally distant from the inducing coils, but it will give a sound if the distances are unequal.

To have an idea of the transmitter, suppose on the moving shaft of the machine a rigid stem, 1·50 to 2 m. in length, and fixed in a direction parallel to the shaft, to which it is fixed by one end, while at its free extremity it supports the induction coil. If we place on the shaft opposite this coil an induced coil, at a certain distance, and in such a manner that their axle may be in the same right line, it is evident from the torsion of the shaft in that part of its length occupied by the rigid stem the inducing coil will approach to or depart from the induced coil, according to the direction of the rotation, and that the distance of the coils will have a relation to the motor effort—a relation which must be determined experimentally.

The receiver is composed of two coils identical with those of the transmitter, placed in the same manner and at the same distance. One of them can slide along a graduated scale, approaching or receding from the fixed coil.

Let the inducing coils of the transmitter and the receiver be arranged in tension in a circuit containing a battery, and an interrupter formed by a toothed wheel insulated upon the motor shafting. At each revolution of the shaft we shall have in the circuit a number of currents equal to the number of teeth in the wheel. The induced coils connected in tension, being introduced in another circuit containing a telephone, the latter will emit a very

ROMAN HONORS TO GARIBALDI.—THE PROCESSION AT MOUNT TARPEIA.

loud sound if the exciting currents are turned in the same direction in the induced circuit. But since the inducing coils are so disposed as to excite contrary currents in the induced coils, the telephone will be mute if the distance of the coils of the receiver is equal to the distance of the coils of the transmitter. We proceed, then, as follows, to determine the effort transmitted to the axle of the machine.

Move the coil of the receiver until the telephone becomes mute; then the distance of the coils of the receiver will be equal to that of the coils of the transmitter. We know then the motive effort, since we have previously determined this effort corresponding to different distances of the coils, and may write it upon the graduated scale. If L is the arm of the lever of the ascertained effort the work of the machine at each turn of the shaft $=2\pi LF$.

But to calculate the work of the machine in a unit of time we must know the number of revolutions of the shaft per second. For this purpose we place at the side of the telephone of the receiver a tuning-fork, the branches of which support two equal masses which may be displaced; for each position of the masses there is inscribed upon the branches the number of vibrations corresponding. It is then easy to determine the number of revolutions of the motor axle in a unit of time. We listen to the telephone, and at the same time to the tuning-fork, and we move the masses until it is in harmony with the telephone. Let N be the number of vibrations of the tuning-fork; the number n of the teeth of the interrupter-wheel being known, the number of revolutions of the motor shaft per second will be $\frac{N}{n}$. We have then the elements of the work, which is given by the formula

$$T=2\pi LF\frac{N}{n}$$

If the shaft of the machine is not long enough, the transmitter must be modified. When the movement is transmited to the shaft by means of a driving-belt, it may be arranged as follows: A loose pulley is connected by springs to a pulley fixed upon the shaft; to this is applied the inducing coil and to this again the induced coil, and they are placed opposite each other at a suitable distance. In other respects the above arrangement is preserved, and the elements of the work are determined in the same manner.

It has been supposed that the distances of the coils of the receiver are equal to that of the coils of the transmitter when the telephone is mute. It may happen that this is not the case; still, since at each effort applied to the motor shaft we have determined the distance for which the telephone is silent, the number written upon the scale will always give the effort transmitted. It has also been assumed that the torsion is constant during the experiment. It may, however, vary periodically at each revolution of the axle. In this case the position of the telephone, when emitting a sound of minimum intensity, will give the *mean* effort.—*Comptes Rendus.*

## THE ATTITUDES OF ANIMALS IN MOTION.*

By MR. MUYBRIDGE.

THE attempts to depict the attitudes of animals in motion probably originated with art itself, if, indeed, it was not the origin of art; and upon the walls of the ancient temples of Egypt, we still find pictures of, perhaps, the very earliest attempts to illustrate animal motion. But artists of all ages seem to have followed peculiar grooves in this matter, and to have adopted uniform notions as to the movement of animals. How inaccurate these notions have been, I shall endeavor to demonstrate to you this evening. I will commence, however, by showing you the apparatus by which the photographs were made; you will then better understand the pictures themselves. Here is the apparatus, consisting of an ordinary camera, in front of which is a strong framework, inclosing a couple of panels, each with an opening in the center, sliding, one up and one down. In connection with it is an electromagnet, which, on completion of a circuit of electricity, causes a hammer to strike and release a catch which holds the shutters in position; the back shutter is then drawn upward by a strong India-rubber spring, and the front shutter is simultaneously drawn downward. Here is a photograph of three shutters in position, one showing the panels before exposure, one during exposure, and a third after exposure. The next picture shows the arrangement in front of the cameras. Here are a series of strong threads stretched across the track, each of which being pressed forward, causes two metal springs to touch, and thereby completes the electric circuit. These threads are arranged at a distance of 12 in. from each other, and as the horse passes along he thrusts the strings, one after the other, completes an electric circuit, which operates the shutter of the particular camera which he is passing at the moment.

Twenty-four cameras are arranged parallel with the direction of the animal. The next picture shows the entire photographic arrangements. The track is covered with India-rubber, to prevent dust flying from the horse's hoofs; and there are here five cameras arranged in a semicircle, the object of which I will explain presently. The result is this: A horse, in his progress over the track, comes in contact with these threads successively, and is photographed in the position in which he happens to be when he strikes the thread; then he moves 12 inches, and of course assumes another position, and is so photographed, then another 12 inches, and so on; in this way we have several positions assumed by an animal during an entire stride. The time of exposure, I may say, is the one five-thousandth of a second.

Here is a scale I have drawn out, but which it would take me nearly an hour to explain, illustrating the position of a horse's feet during the various strides, the walk, the trot, the gallop, and the pace; if any one feels sufficient interest in the subject to inquire more thoroughly into it by-and-by, it will afford me a great deal of pleasure to explain it.

Now, as I have spoken of the faults of artists, I must show you what those faults are. Here are some pictures of horses walking, from different sources, with some of which you are all no doubt familiar. One is from Egypt, where they seem to have had two modes only of illustrating the motion of an animal, one the walk, the other the gallop. Here is one walking, with all four feet on the ground at once. As a general rule—indeed almost always—they are going from left to right. You will notice that the lateral legs are represented as moving synchronously, both left legs touch the ground at the same time, and both right legs. Here are other examples of Assyrian and Greek art; a Roman of the first century and one of the eighth century, also a Norman horse from the Bayeux tapestry, a German horse, and one by Flaxman, which is the only correct one of the series. I would particularly call your attention to a representation from the column of Theodosius, where you see two mules, in one of which the hind legs are precisely in the same position as those of the mule in the next illustration, while the fore legs are totally different. Now, a mule or a horse always walks in the same way, so that if one is right the other must be wrong.

Here are photographs of a horse in the act of walking. A horse, while walking, is alternately supported on three feet and on two, and the two are alternately diagonals and laterals. Some very eminent authorities have asserted that a horse, while walking, has never more than two feet on the ground at the same time; but he has always two—that is the characteristic of the walk—and invariably three, four times during each stride, two hind legs and a fore leg, alternately with two fore legs and a hind leg. This horse, you observe, is standing on the right laterals. The most common fault of artists in representing the walk is to mistake the laterals for the diagonals; it arises, I am satisfied, from carelessness and lack of observation. Whenever a horse or any other animal has two suspended feet between two supporting legs, those two suspended feet are laterals, never diagonals. You find them in pictures, engravings, and even in sculpture, quite as frequently represented one way as the other; but they are invariably laterals—that is, when they are suspended *between* two supporting legs. When supported on diagonals, suspended feet are outside the supporting legs. Here is a horse walking, photographed simultaneously from five different points of view, according to the arrangement of the cameras I referred to just now. Next, we have a photograph showing the regular series of positions taken by a horse while walking. Of course, in every thousandth part of an inch a horse really gets into a different position, but these are all the positions of a stride which are worth illustrating.

Next we have the amble; and first I show you some specimens of Egyptian, Assyrian, Etruscan, and Modern Italian art. They are none quite correct, but they approach more nearly to the gait which is ordinarily called the amble than any others I have found. I do not know whether this gait is properly understood or appreciated in this country, because horses are not trained to it, but Spanish horses are invariably taught it. It is faster than a walk, but not quite so fast as a trot, and is an easy, sliding motion, alternately on one foot and on two feet. In this, as in the walk, the horse is never entirely off the ground; in all other gaits the weight is off the ground entirely during a portion of the stride, but in these two he is never clear of the ground. He is alternately on one hind foot, then on two laterals, then upon one fore foot, then on the diagonals, then on a hind foot again. The succession is very curious; first on one foot, then on two; the two feet being alternately diagonals and laterals.

When these photographs were first made, some experts had doubts as to their accuracy. We have here a little instrument called the zoöpraxiscope, with which we can throw the various positions in rapid succession on the same spot on the screen, and thus produce apparently the real motion, and you will readily understand that if any of the positions were incorrect, it would upset the experiment altogether.

Next we come to the trot, and as before, I first show you some samples of ancient and modern art. There is Marcus Aurelius on horseback, but that is not a real trot, because in a trot the motion of the diagonals is more synchronous than is here represented. The best example of a trot I have been able to discover of mediæval times is from a stained glass window in the Cathedral of Chartres. There are two from the Louvre, representing Louis XIV. and Louis XV.; none of them are quite correct, but none have such glaring faults as one by a very celebrated artist, Rosa Bonheur. She is, perhaps, one of the greatest artists of modern times; grand in coloring, splendid in drawing, a great observer of nature, but, unfortunately, she did not pay sufficiently strict attention to the positions of animals in motion. This is a very celebrated picture, and the horse is supposed to be trotting pretty fast. Now, one fore leg is extended backwards, really beyond the center of gravity of the horse. It would be utterly impossible for him to bring it forward in time, at the rate he is going, to support his body, and he would be obliged to fall down—he could not help it.

Here are a series of photographs of a horse trotting at about ten miles an hour, showing all the various positions at the different periods of the stride. Now, to me it appears almost incomprehensible, but until these experiments were made, it was a question with some very experienced horse drivers whether a horse was entirely clear of the ground during a trot. Some imagined that he always had one foot on the ground, though I cannot see how it was possible for them to come to that conclusion. Even at a moderate rate, in trotting, the weight of the body is entirely unsupported by the feet, though they may drag along the ground at a certain portion of the stride, no matter how slow the pace. This being about ten miles an hour, the horse is entirely clear. Here, again, is a horse trotting at the rate of a mile in 2 min. 20 sec. One thing I would call attention to is this, that when a horse's foot strikes the ground, the leg is always straight; it is never in a bent position. Though you find some eminent artists illustrate a horse striking the ground with his leg bent, it simply is not possible. Another thing is, that he always strikes the ground with his heel first, never with his toe. Here is another horse performing a moderately fast trot, about 8 miles an hour, and making a stride of 6 ft. 6 in. Here is another trotting very fast—1 mile in 2 min. 18 sec.; the fastest time ever accomplished being a mile in 2 min. 10 sec. There is also a peculiarity observable with regard to the position of the pastern. When striking the ground it is vertical, but it immediately sinks so as to become almost horizontal. Now, we will try the trot with the zoöpraxiscope, and you will find the motion is perfectly produced.

Next we come to the canter, which is rather a peculiar gait. It differs from the gallop in many respects, and notably in this, that whereas in the gallop the horse will leave the ground with the fore feet, as also he does in the canter, in landing in the gallop he lands first on one hind foot and then brings down the other hind foot, so that he will be on two hind feet at the same time, and throwing his fore feet forward; in a canter he will land on one hind foot, and the next foot to touch the ground will be a fore foot; then he will bring down the other hind foot, and then the next fore foot. That is the invariable order of succession in the canter, but the hind foot will follow the fore foot so rapidly that it is utterly impossible for the eye to follow the succession of movements. Here we have a series illustrating the canter. You see he leaves the ground on the fore foot, as is invariably the case with either the canter or the gallop. That is another singular fact that artists have not noticed, and they have been led into the very egregious error of imagining that a horse, while galloping, left the ground with the hind foot and landed on the fore feet. A horse, while galloping, is always in the air for a certain portion of time, but it was always supposed that in galloping he would leave the ground with the hind feet and land with the fore feet, whereas the reverse is always the case.

We now come to the fastest of all gaits—the gallop. Here is the Egyptian representation which, with very slight variations, is the way in which Egyptian horses galloping are always represented; the hind feet are down, and the fore feet in the air. The Assyrian is not much better, but the Greeks evidently understood the motion of a horse better than a great many of the moderns; and this is very nearly the position in which a horse would be, having just landed after a flight through the air. He has struck the ground with his hind feet, one hind foot being behind the other. Here is another from the column of Theodosius; here is a Norman example from the Bayeux tapestry; and here is one by some Italian artist of the fourth century, in which we find a position of the gallop exactly reproduced. Here is one by Albert Dürer; this is the conventional gallop; and, with all due deference to the artists who have palmed it off on the public as being a representation of a galloping horse, I must say it is really absurd, because it is utterly impossible for a horse to get into that position. Here are some ancient pictures, one from the ruins of Angar Wat, in Cochin China; a Japanese, which is tolerably correct; and a very curious one, copied from a painting on the rocks on the banks of the Yenisi by the Tartars. This shows how artists of different ages and different countries have all agreed in representing nearly the same conventional position of the gallop.

While on the question of the absurdity of this position, I may remark that where there are ten horses it is a concentrated absurdity—it is ten times as absurd—because if it were possible even for one horse to get into that position, it would be certainly the height of improbability for ten horses, at the same instant of time, all to be in the very same position; yet here is a picture by a distinguished artist, Mr. Herring, a very celebrated painter of horses. He has painted ten horses all fully extended in that conventional position. The public may have demanded that, and be painted that picture in that way. It is necessary that the public and the artist be educated together. Here we see a photograph of a free gallop, with a horse just about alighting on the ground still in the air. When the horse is in the air, it is not with his feet stretched out as far forward as they will go, and the two hindmost in the same way, but they are curled up invariably in the way you see them in this photograph. That horse is now in the air, about to alight on the hind foot. In another one, you see him alighting on the hind feet, and, of course, there are intermediary positions between these; and this where he is about to leave the ground with one forward foot. Those connected with the turf are well aware that, when horses break down, they always break down with the fore feet, and never with the hind feet, or very rarely. It was a mystery why that should be so, but here is the key to it; the immense amount of work that a race-horse has to perform with his fore legs is fully equal, in my judgment, to that with the hind legs. Here are all the important positions which a galloping horse will assume in making a complete stride. In its particular features each stride really differs from another. If you take one of the swiftest race-horses, and measure his stride, you sometimes find one inch, sometimes two, and sometimes half an inch variation in the length of the stride; it depends on various little things, but this is a representative stride. Here is another, with a little longer stride—19 ft. 9 in.—in a stride of 25 or 26 feet. We might have information different to that we have obtained.

Now we come to the leap. This is the horse rising preparatory to clearing the hurdle. The hind feet are on the ground for the last time before making the spring, and you notice that one is much in advance of the other—a few inches; sometimes it is more than that. They are hardly ever at precisely equal distances from the hurdle, and on coming down, you find a greater variation. I may say that these pictures are entirely untouched; they are exactly as they were made in the camera; there is no interpolation by any artist, or any imagination. Here the horse is coming down; one fore leg you see is nearly straight, the other is somewhat curved, because he has not had time to bring it out probably; it will be perfectly straight when he touches the ground. Here he is landed, and you notice that one pastern is almost horizontal. That is the position in which a horse invariably strikes the ground. Here we have an entire consecutive series taken from a distance of about twenty feet in front of the hurdle. There is more variation in the leap of the horse than in almost any other movement. Sometimes he will leave the ground at a distance of twelve feet from a hurdle 3 feet 6 inches high; at other times he may probably not leave the ground until 3, 4, or 5 feet of the hurdle. It depends a great deal on the disposition of the horse. Here is a series illustrating his position after he has cleared the hurdle, showing the method by which he picks up his feet, and regains the gallop, after having made the jump. This is a complete stride, and we can follow the horse here from the time he leaves the ground with his feet until he lands with his forefeet. I will now illustrate this movement with the zoöpraxiscope. Here are some photographs of the dog. In fact, some people might mistake that for a horse, because the position is somewhat like the conventional horse gallop. The motion of the dog is very peculiar. Here he has alighted on one foot, changed it to the next fore foot, and then he leaves the ground with the fore feet. In the next you find him entirely in the air, his feet all doubled up under him; he then comes down on his hind feet. Then he brings the next hind foot down, and leaves the ground again, so that he is in the air twice during a single stride—once with his body curled up, and the other when perfectly extended. I do not think that fact has ever been commented on by a writer on natural history. Here is a photograph of two dogs running a race; they were photographed together; one was a faster dog than the other, and you see how he gradually overtook his competitor.

Next we have the ox; here are two oxen from the column of Theodosius, and they are both correct. There is one peculiar feature in the walk, of which I should like to tell you. Artists ought really to be close observers of animal movements, but it is rare to find an artist who can tell you the manner in which an animal will walk. There are two artists here, and they have not been able to tell me. There is one invariable rule with regard to the walk, so far as my observation has extended, and that is that the succession of footfallings are with any animal precisely the same; whether a dog, a horse, a monkey, or the giraffe, they are all the

* A paper read before the Society of Arts, London, 1882.

same. Assuming you commence your observation with the left hind foot, the next foot to touch the ground would be the left fore foot, followed by the right hind foot, and that again by the right fore foot. That order, so far as I am aware, is universal. I would not be positive so far as all animals are concerned, the hippopotamus for instance, but, so far as I have had an opportunity of judging—certainly, so far as I have photographed—it is so. You may think it a very easy thing to watch an animal, and see how it walks, but it is very difficult. There is as much difficulty in watching the massive movements of an elephant as the more light and rapid movements of the horse. I am not quite satisfied in my own mind yet whether an elephant is upon diagonals during a walk or not; I know he is on laterals, but during half an hour's observation I could not really positively say whether he was supported by the diagonals alone or not. With the hippopotamus I know that to be the case, but I almost question really whether an elephant in walking is supported entirely by diagonals. Here again we have a picture of an ox, by Rosa Bonheur. This is a very celebrated picture in the Luxembourg. Those two oxen are represented in a manner that no oxen would ever think of getting into. You might get a cord, and pull their feet into that position, but it would be strongly against their will. There is another one here by the same artist which is more nearly correct, but not quite.

Next we have a series of photographs of an ox walking, and the same principle holds good. The succession is the same. The trot of the ox is pretty much the same as that of the horse. The next is a wild bull; he was really wild enough for a Spanish bull fight; we had to build a long lane in order to get him to run straight, and we had three or four men ready to catch him in case he should make for the cameras. The bull gallops pretty much like a horse. Next we had a set of photographs of the pig I thought I would attempt the pig, not that I hoped to gather much information from his movements. The principal event of our experiment was the difficulty we had in inducing him to go forward; of course we followed the old principle of drawing him backwards.

Next I have a set of photographs of the deer. Some writers on animal movements have compared the gallop of a horse to that of the deer, but there is really a considerable difference. We see that the deer takes somewhat the conventional style of the horse in galloping. The gallop of the deer is hardly a gallop, it is almost a series of bounds. The deer does leave the ground with the hind foot, and lands on the fore foot, which the horse does not.

Now, we come to the movements of mankind. This man is walking pretty fast, a seven foot stride. With regard to the walker, we all know that he lands on the heel; but in taking a run, if you ask any athlete in what manner he runs I think he would tell you that he would not alight on the heel, that he would alight on the ball of the foot. They are generally very confident that in running they never come down on the heel. That is the opinion of the runner himself, I think, in nine times out of ten, and it was with very great difficulty, after this man had run, and had seen these pictures, that he could convince himself of the fact that in running he always came down in this manner. It is the same with the man as with all other animals, as far as I am aware: they always come down on the heel. Here is a photograph of a long jump of 16 feet, without any particular attempt to jump high. Here is one of a man clearing a hurdle four feet high. You would think that clearing a hurdle of that height, if it were possible for him to come down on his toes, and so break the force of the concussion by springing, that he would do so. But you see here where that man's toes are. He comes right down on the heel, and that is the only way in which he could come down. The man finds his springs in his knees when jumping; the horse finds them in his pasterns. [The various movements in running and jumping were then exhibited in the zoöpraxiscope.]

In the next photograph we see men performing athletic feats, particularly feats of strength. They are on too small a scale to show the play of the muscles. But I have a series on a larger scale of men wrestling, in which the action of the muscles is very well shown. This series of exposures was made in a slightly different way. Of course, the men in wrestling were pretty much in a small circle, and, therefore, different means had to be adopted for regulating the successive exposures. The cameras were all concentrated on one point, and an apparatus was constructed to cause them to receive the exposure at stated intervals of time, instead of distance. Here are photographs of a twisting somersault; next a flip-flap, in the movement which is made preparatory to making a back somersault; and here is a back somersault. I will show these in the zoöpraxiscope. Of course, the construction of this instrument requires the movements to be effected more rapidly than a man in performing the same result would naturally do. The horse on which he is standing, instead of making two strides, would probably make three or four before he turned the second somersault. But in order to show that, it would require a disk of 10 feet circumference.

At the request of my friend, Professor Marey, of Paris, I give some attention to illustrating the position of birds, but I cannot say I was very successful. The movements of the wing are so extremely rapid, and it is a small object any way, so that the information we have obtained from the movements of birds I cannot congratulate myself upon; however, here are a few of the results. There are only two nations, that I am aware of, in which the artists have ever thought of illustrating birds with their wings downward; of course, artists must know that birds' wings go down, but I suppose they imagine it is inartistic to draw them in that way. The ancient Egyptians would frequently illustrate their birds with the wings downward, and the other nation is the modern Japanese. You frequently find, in Japanese books, birds illustrated with their wings downward. I show you these few photographs of birds, but, perhaps, they are of more value for art than for science.

I have now some illustrations of groups of horses galloping. These really are more difficult to make, because they were made in the open fields without any of the apparatus which I have described. There are also a few picture subjects, showing groups of horses, which are, perhaps, more interesting to the artist. Lastly, I will show with the zoöpraxiscope a picture, which we may call Rotten Row. [This was a picture of a number of horses, dogs, and men, showing the various motions of running and trotting.]

In conclusion, I have only to say that, if there is any one who desires to investigate the subject further, it will afford me great pleasure to give every information in my power.

The Chairman said he was quite sure it would be unnecessary for him to say that all the members present must feel as he did himself, greatly indebted for the kindness with which these processes had been placed before them; and he might also say that very many would feel great admiration for the perseverance and skill with which this matter had been developed. There was no doubt at all but that there were very few who were even aware of the movements of their own limbs. He confessed it was a matter he had thought a good deal about at times, but had never been able to realize to his own satisfaction how it was he was able to walk. He was, himself, some years ago, made aware that the amble was particularly well developed, not only among mules in Spain, but was a very favorite gait among the Dutch of South Africa. Every man there taught his horse to amble. He had a horse himself which was a very good ambler indeed. He had studied the movements, he might say, for years, but he could not make head or tail out of them. He had watched the horse again and again in a most close way—as an anatomist, as an observer, and as he should imagine an artist would—but he did not know how it was that the amble was got out. He referred to this in order to bring before the meeting how valuable, on scientific grounds, was the apparatus they had had displayed. If that apparatus were made use of to study the movements of a horse or any other animal, it was possible, by careful observation, to ascertain exactly what the animal did, and he could prove that in an admirable way. In the amble there was a peculiar sense to the rider; it was a movement, as they had heard, in which the back of the horse moved very little indeed out of one plane, but the rider was conscious of a singularly slight oscillation from side to side in the same plane; it was a very easy gait. You simply felt a slight jerk sideways, and when you once got accustomed to it, you could never forget it. Now, he had noticed on the screen that the man on the ambling horse had distinctly that sideways motion, which he had himself felt in riding. He mentioned that to show how exact this apparatus was. He was sure they would all join in a hearty vote of thanks to Mr. Muybridge, and he was sure they would all be willing to express their admiration, not only for the skill and scientific accuracy with which this had been developed, but for the interesting way in which it had been brought forward.

The vote of thanks having been passed,

Mr. Muybridge, in returning thanks, said he might illustrate what Dr. Mann had said with regard to observing the peculiarities of the amble. An able article recently appeared in the *Builder*, upon the physiognomy of motion, stating that every man had a motion peculiarly his own, as much so as his features; so that although a man wore garments with which they were unacquainted, his friends would recognize him at a distance by his gait. Now, he could illustrate that with regard to the gait of horses. In the first series he made, showing a horse in the act of galloping, he showed it in triumph in the zoöpraxiscope, to the owner of the horse, Mr. Stanford, and said he supposed he would recognize his horse Florence Anderson. "Well," said Mr. Stanford, "you have got a galloping horse there, but it is not Florence Anderson." He replied that it was, that the trainer had sent it out to him, and that was a picture of it. Mr. Stanford said he was quite satisfied that it was not Florence Anderson, and on the man being sent for, it turned out to be another horse. That showed that not merely a galloping horse could be illustrated in this way, but that even a horse's peculiar gait could be so rendered by the instrument that it should be recognized by any one familiar with the animal. He could not, perhaps, distinguish the gait of one from the other, but the owner could at once. Another thing he should like to remark was that he did not by any means exhibit these as perfect pictures, but simply as experiments, and next year he should hope to be able to show experiments more worthy of approval.

## PLENER'S IMPROVEMENTS IN METHODS OF TREATING EMULSION.

WE now lay before our readers a brief description of Mr. Joseph Plener's new method of treating emulsions as we have seen it at work. In general terms the process is one for mechanically separating the silver bromide from the gelatine and soluble constituents of the emulsion, thus obviating the necessity for the prolonged and tedious washing ordinarily necessary. This is effected by causing the mixture to revolve at a high rate of speed in a suitable vessel, when the particles of bromide are completely separated from the liquid portion of the emulsion, and find their way, by centrifugal force, to the sides of the containing vessel. The whole of the gelatine and soluble nitrates can then be easily poured off and replaced by perfectly new and pure material, thus securing rapidly and perfectly the result, attained slowly and but ineffectively by the usual washing method. This is the main use of the process, though it has other applications, which will be noticed as we proceed.

The machinery employed by Mr. Plener is of the simplest description, though necessarily of most perfect construction. The separating vessel—which is conical in form and open at the top—is of turned gun-metal, and capable of holding from one hundred to one hundred and fifty ounces of emulsion. This is connected directly with an upright revolving spindle, by which the revolution is transmitted from an engine of ordinary construction. In his first experiments Mr. Plener used vessels of sheet copper, and some idea of the enormous strain put upon them by the high rate of revolution may be surmised when we state that the bottoms of several were completely torn out by the force. Accurately-turned vessels cast in gun-metal have now been substituted, the internal surface being electro-plated to prevent any injurious action on the emulsion.

The *modus operandi* is as follows. The emulsion having been made by any of the ordinary methods is supposed to have reached the stage, after cooking, when it is ready to be washed or to have the soluble salts and decomposed gelatine separated from it. It is rendered liquid and poured into the separator, which is closed by means of a bung. As the vessel is made to revolve slowly, heat is applied by means of a gas jet attached to a flexible tube, and this is continued at intervals during the progress of the operation in order to keep the gelatine perfectly fluid. As the speed increases the hum caused by the rapid motion gradually becomes clearer and more pronounced, until it reaches a clear, musical tone, when the speed is five or six thousand revolutions per minute. This treatment is continued for from five to ten minutes, according to the state of the original emulsion; the finer the state of division of the bromide the longer it takes to separate.

The separation being judged complete, the machinery is permitted to slacken speed very gradually, and when stationary the vessel is opened and the contents examined. If the separation be perfect not a trace of silver bromide is visible, the vessel containing apparently nothing but clear solution of gelatine, through which the bottom and sides of the separator are plainly visible. It is only by thrusting the finger on to the angle formed by the sloping sides with the bottom that the precipitate of silver bromide is discovered, and here it is found to have massed itself in a compact, adhesive ring or layer. The gelatine is siphoned off, a little clean water introduced into the vessel, and the "whirling" repeated when the last traces of soluble matter may be easily removed, and nothing then remains but to make up the bromide with its proper complement of gelatine, or, if preferred, to dry and store it away for future use, either in gelatine or collodion emulsion.

It is obvious that, should any fog be present in the emulsion, caused by decomposition of the gelatine or by the formation of soluble silver compounds, this method of treatment would seem to offer a chance of removing the evil, and, in fact, Mr. Plener finds such to be the case, red and green fog being entirely eliminated. But, further than this: if from over-coating or other cause a coarse, granular, and foggy precipitate of bromide be formed in the gelatine, this may be separated from the rest and a workable emulsion produced. By virtue of their greater size and weight the coarse particles are first expelled, and by adapting the treatment to the precise condition of the emulsion to be acted upon, any desired effect may be obtained.

In adapting the process to the recovery of silver bromide from decomposed emulsions we find another possibly useful application, and one which presents a considerable economy, both in time and material, over the usual methods of the refiner; for the silver salt, still retaining its photographic properties, is simply transferred to new gelatine, and thus forms at once a perfect emulsion.

It is impossible at present to foresee the exact future of Mr. Plener's method, but we shall keep it in view, and we hope on a future occasion to have something to say on its purely scientific aspects.—*British Journal of Photography.*

## THE MANUFACTURE OF THE COAL-TAR DYES.

### PREPARATION OF NITROBENZOL AND ANILINE.

*Benzol.*—The particular kind of benzol to be transformed into aniline, or, as it is more properly called, phenylamine, of course, depends upon the class of aniline which it is desired to make, and the different qualities of this compound produced are again dependent on the colors for which it is to be used. For magenta a quality known as 30 per cent, or 40 per cent. is required, while for blue 90 per cent. or pure aniline is necessary, these last-named qualities being also used for aniline black. When the benzol is bought and sold, it is therefore valued according to certain agreed boiling points, which are determined by experiment. For this purpose an apparatus, such as shown in Fig. 1, is employed;

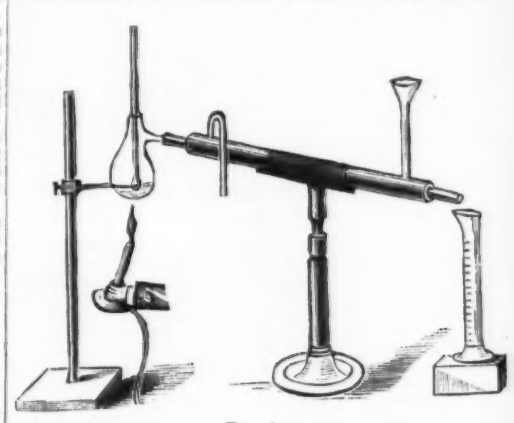


FIG. 1.

100 cub. cents. are measured into the small retort, and a small gas flame held under until the boiling commences; the temperature is noted on the thermometer, and entered in a book kept for the purpose. As the ebullition proceeds the number of c. c., which are stilled and condensed between any agreed degrees, are collected in the 100 c. c. measure, and also entered in the book. As an example, we will suppose the quantities are taken between every 5°:

| B. P. | 90° C. | 95° C. | 100° C. | 105° C. | 110° C. | 115° C. | 120° C. |
|---|---|---|---|---|---|---|---|
| 85 C. | 15 c.c. | 25 c.c. | 30 c.c. | 40 c.c. | 65 c.c. | 75 c.c. | 100 c.c. |

It will be seen that this benzol gave 30 c.c. at 100°. Pure benzol is now frequently used which boils at 82°C., and will give 100 c.c. at 82·5° C. or 83° C.

*Nitrobenzol.*—The quality of the benzol to be transformed having been determined upon, and the boiling-points found to be such as desired, the above compound is formed by the action of nitric acid (1·40° specific gravity) and sulphuric acid (concentrated) on benzol. These are mixed in the proportion of two parts of the former acid to one of the latter. The apparatus in which the operation of nitrification is performed (Fig. 2) consists of an upright cylindrical vessel, with a rib cast on opposite (inner) sides, extending from the top to the bottom, standing about two inches high (from the sides). Down the center of this still is a cast-iron shaft, standing in a footstep. At the bottom an agitator is attached, having a number of holes in it. At the top of the shaft a bevel wheel is attached, and geared to this is another bevel wheel, fixed to a horizontal shaft, carrying near the end a fast-and-loose pulley. The bottom of the still must be slightly hollowed, and a little gutter made from the footstep to the plughole, which is constructed so that an earthenware tap can be fixed in it. The bottom so constructed admits of the still being thoroughly drained. There is fitted to the lid—which is constructed to form a dish to hold water—about halfway between the center and outside, and passing through two or three inches, a piece of half-inch lead pipe, with a funnel at the top. This is where the mixed acid is introduced, and is bent into the shape of the letter ∞. The still is jacketed about three-fourths its height, to allow a flow of cold water while the operation is proceeding. The amount of benzol to be transformed, which depends upon the size of still—say 15 gallons—is put in, and the agitator set running. The mixed acids are run in through the ∞ pipe by means of a siphon, made of one-fourth inch lead pipe, and having a glass or earthenware tap fixed to the outlet, so that the stream may be regulated as soon as the proper heat is developed. The flow of acids is continued until it amounts to 510 lb. When this quantity of acid is run in the agitation is continued for a few hours. If during the operation the temperature shows any signs of lowering, the stream of cold water is stopped. The vapors arising from the combination are conducted, through

earthenware or glass pipes, into a couple of Woulfe's bottles and condensed. The reaction which takes place is explained by the following formula—

$$C_6H_6 + HNO_3 = C_6H_5NO_2 + H_2O$$

Benzol and nitric acid form nitrobenzol and water.

The object in using the sulphuric acid is to absorb the water formed by the reaction, and thus prevent dilution of the nitric acid. After the treatment described above, the contents of the still are allowed to rest ten or twelve hours, so that the uncombined acid may thoroughly separate from the nitrobenzol. These are separately drawn off through the tap. Before this nitrobenzol is fit for making into aniline, the small quantity of acid which is still mixed with it must be removed. This is done by washing. The dirty nitrobenzol is put into a tub (this may be lined with lead) or a cast-iron cistern the shape of a funnel, lined with lead, and a lead-covered earthenware tap fastened to the bottom for decantation is sometimes used. A gallon of strong caustic soda solution is poured in along with a bucket of water, and the contents of this washing vessel thoroughly stirred with a wooden crutch. After subsiding, the soda combined with acid can be drawn from the bottom. This mode of washing is repeated three times. To finish, the nitrobenzol is washed twice with clean water, and, as it is the heavier body, is drawn first.

*Uses of Refuse Acid.*—The large quantity of refuse (waste) acid from this manufacture is used in various ways, such as for making copperas, the nitrous acid evolved from the nitric acid being condensed in soda to form sodium nitrite, and as such used for forming azo compounds; sometimes, after removing the nitric acid by heating in thick cast-iron vessels, for the manufacture of sodium sulphate and hydrochloric acid; while others use it for nitric acid making. It has been suggested that this acid might be more profitably employed in the manufacture of artificial manures, on account of the nitrogen it contains as nitric acid. Probably it might be concentrated in earthenware stills similar to those used for chlorine making, the nitric acid condensed, and the sulphuric acid used for the manufacture of strong nitric acid.

*Aniline.*—The nitrobenzol obtained by the foregoing operation, which, if the operation has been properly attended to, should contain very little or no uncombined benzol, is transformed into aniline by the chemical process known as reduction, and is accomplished by means of the nascent hydrogen produced from the decomposition of water by iron. The whole of the nitrobenzol to be converted at one operation is put into a cast-iron apparatus, consisting of a cylindrical vessel, something like the one used for nitrobenzol, but having a hollow shaft. The diameter of the hole

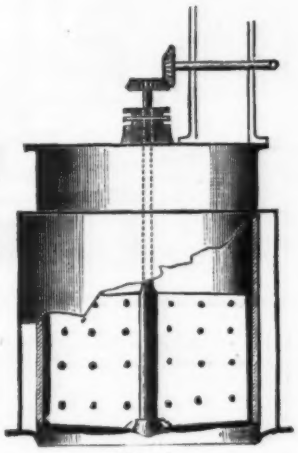


FIG. 2.

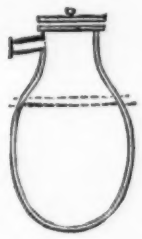


FIG. 3

is generally about 1¼ in., the lower end of which is made square, so that an agitator 8 in. broad can be secured on opposite sides. These agitators are set to incline at an angle of 45°. This is done to make them lift the iron borings off the bottom of the still when they are in motion. On each of the other two sides is a hole running into the center hole of the shaft, and to each of these a piece of perforated iron pipe is attached, having the ends plugged. They are situated two or three inches lower than the top of the agitators, and admit the steam into the charge contained in the still. At the top of the shaft a stuffing box is made, so that a steam pipe can be connected to it; and below this gearing is attached similar to that on the nitrobenzol still, but stronger, as the weight to be stirred is greater in this case. A suitable manhole is made as near the bottom of the still as possible, to allow of its being conveniently cleaned after each operation. The lid carries a large funnel, where the iron borings are introduced, and this is stopped with an iron or wooden plug when the apparatus is in use. An S-shaped pipe, with a small funnel at the top, is also fixed to the lid, where any liquid can be poured through, besides a pipe of large diameter, through which the vapors are conducted to the condensing coil. Sometimes a small engine is attached to each aniline still, which is a good plan where the number of stills to be worked at one time varies. To the nitrobenzol which has been put in the still there is added about 2 per cent. of hydrochloric acid, and 10 or 12 per cent. of water, and the stirring apparatus set in motion, and one or two buckets of moderately fine iron borings are added. If the reaction does not shortly commence, which is ascertained by feeling the outside of the still when a moderately quick rise of temperature should have taken place, the contents are warmed by turning in steam through the hollow shaft, to start the chemical action. As soon as this happens the steam is stopped. When the charge has become very hot, iron borings are added at intervals, so that the reaction is kept going vigorously. The vapors arising from the reaction contain some nitrobenzol carried by the steam, and must therefore be condensed and returned to the still, or there must be a coil attached in such a manner that these vapors are condensed and flow back into it. The addition of iron borings is continued until the heat shows signs of lowering, and will not rise again on adding a small quantity of iron borings. To 1,000 lb. of nitrobenzol 1,200 or 1,300 lb. of iron are required. The decomposition is explained as follows:

$$C_6H_5NO_2 + H_2O + Fe_2 = C_6H_7N + Fe_2O_3$$

Nitrobenzol and water and iron produce aniline and ferric oxide.

When the reduction is complete, sufficient milk of lime is added to neutralize the hydrochloric acid employed, and the aniline separated from the magma of ferric oxide, etc., by rapidly distilling with steam in the following manner: the steam is admitted through the hollow shaft, and the vapors produced, carrying the aniline mechanically suspended, are conducted through a cooled coil, where they are condensed and received in a suitable vessel. To ascertain when the aniline is all out of the contents of the still, a small quantity of the distillate is collected in a large test tube or other clear glass vessel, the point being determined by the absence of any small globules of aniline suspended in the water. When this is the case, the steam is stopped, and the aniline and water are separated by decantation. The former compound has to be dried, by a process to be presently described, before it is in a fit state to be used. The water is stored in a large cistern, and used to raise the steam in a special boiler, for the aniline stills, as it contains about 2 per cent. of aniline dissolved in it. The residue which remains in the still is removed by the manhole at the bottom, and is useful for several purposes, to be presently spoken of.

The *drying of the aniline* is performed in a still of cast iron, made similar in shape to an egg, the apex of which carries a large neck, covered, when in use, by a lid secured with nuts and screws. On the side of this neck and close under the flange a short pipe is attached, which slightly dips from the still, and is connected to the condensing coil. These and all similar coils can be obtained ready made, of wrought iron, from some tube manufacturers, and of any length and shape. The stills are about one inch thick, except at the bottom, where they are stronger, and sometimes cast in two parts, as shown by the dotted line in Fig. 3, but are better if in one piece, as they frequently are, since it saves the trouble and annoyance caused by a joint. They are set in brickwork, and heated by fire. The wet aniline is pumped into this still, and the fire lighted. The distillation is very gently proceeded with at first, when the water, mixed with some aniline, comes over first, after the water is stilled off, which is ascertained with a glass vessel. When no globules of water are observed floating in the aniline oil the dry aniline is collected apart, and is ready for use, while the first distillate, consisting of aniline and water, is separated, and treated as before indicated.

*Aniline testing* is performed in a manner similar to that described for benzol, the highest qualities of which boil at 181·5° or 182° C., and the whole 100 cub. cents. come over within half of a degree, and others within one degree, etc., and some still 90 cub. cent. from the point at which ebullition commences to 190° C. It is a very important matter to see that the thermometer used is correct, as in those usually sold it will be very frequently found that they lie. In fact it is a question if 5 per cent. of them are correct. The presence of nitrobenzol in aniline is easily found by adding hydrochloric acid to a sample of the suspected oil, and if free from this compound, a clear solution of the hydrochlorate is produced, while turbidity shows its presence, and benzol, if there should be any which has escaped conversion into the nitro compound, will float on the surface of the aniline hydrochlorate solution.

*Aniline hydrochlorates*, or crystals, are produced from the combination of aniline with hydric chloride, and are often called aniline salts. Those made from the better qualities of aniline are used for the production of aniline black. To prepare these aniline salts the required quality of aniline is taken, and sufficient hydrochloric acid added. 100 lb. of aniline require about 142 lb. of acid at 28° T., or 1·14° specific gravity. A little excess of acid is always used. The solution thus formed, and which has warmed by the combination, is poured into earthenware bowls, and allowed to stand until the crystals are formed. These are afterward drained to remove the mother-liquor, and allowed to dry in a warm darkened room. The mother-liquor is not thrown away, but evaporated, and used up. For the adulteration of these salts of aniline, ammonium chloride is generally employed. The *residue* from the aniline stills consists mainly of ferric oxide, which always contains some undecomposed iron borings, and as such is useful for certain purposes. To make oxide or iron minium paint it is necessary to separate the undecomposed iron, which can be used over again, and other coarse matter from the fine oxide, and for this purpose it is necessary to wash it with large quantities of water. The advantages this oxide has over colcothar is its entire freedom from acid, which, according to Dr. G. J. Mulder, never obtains in iron miniums made from such material. The consumption of these paints is large on account of their excellent preserving powers, especially as applied to iron of ships, etc. The following is an analysis of minium:

| | |
|---|---|
| Ferric oxide | 85·57 |
| Water | 6·00 |
| Burnt clay | 8·43 |
| Total | 100·00 |

It is also extensively used by some gas manufacturers to remove the sulphur contained in crude gas.—*Textile Manufacturer.*

## ON THE SPECTRUM OF CARBON.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

THE spectroscopic investigations we have communicated to the Society "On the Reversals of the Lines of Metallic Vapors" have shown the importance of a thorough and accurate knowledge of the ultra-violet spectra of the elements, for it is in the line of the short wave length, as a rule, that the greatest emissive power is manifested, and they are therefore most readily reversed. Thus we have succeeded in reversing upwards of a hundred lines in the ultra violet spectrum of iron (*Proc. Roy. Soc.*, vol. xxxii., p. 404). The necessity for accurate data in regard to this region of the spectrum led us to make a long study of the spectrum of magnesium, and the results of this investigation appeared in the volume of the *Proc Roy. Soc.* just cited. Having had occasion to examine the origin of the different fluted spectra of carbon, it became apparent that a complete knowledge of the relations of these spectra to the simple spectrum of the element could only be reached by the help of a complete record of the line spectrum. Angström and Thalén in their memoir on "The Spectra of the Metalloids" (*Nova Acta Reg. Soc. Upsal.*, Ser. 3, vol. ix.), give a map and table of wave lengths of the lines due to carbon in the visible part of the spectrum, as distinguished from the fluted spectra, given by compounds of carbon—namely, carbonic oxide, cyanogen, and acetylene. These lines, they state, always appeared when very powerful induction sparks were passed through the vapor of any compound of carbon, or between carbon electrodes. This line spectrum is remarkable for simplicity, consisting of eleven lines, of which the single line in the yellow, followed by a triple group in the green, and a very strong line in the blue, recall vividly the spectrum of magnesium; and as we know two modifications of the spectrum of magnesium which seem to be due respectively to the oxide and a hydride, the parallel between the behavior of the two elements is the more striking. The plates of the ultra violet spectra of the metals by the late Professor W. A. Miller (*Phil. Trans.*, 1864) include plates of the spark taken between metallic electrodes in different compounds of carbon, which show with sufficient clearness that there are some five groups of lines in the ultra-violet spectrum of this element. In the observations here described we have preferred taking intense induction sparks between pure graphite poles in different gases.

A figure accompanying the paper represents the ultra violet spectrum of carbon to a scale of wave lengths within the range of the rays transmitted through calcite. The lines figured have been observed in photographs of the spark of a large induction coil, having a large Leyden jar in connection with the secondary coil, between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal gas. The same lines have been observed in photographs of the spark between iron, and between aluminum poles in carbonic acid gas. By comparing the photographs taken under these different circumstances, we have, we believe, eliminated the air lines, which are numerous and strong in the region between H and T, and will form the subject of a future communication, and also the metallic lines which graphite, purified with the utmost care, still exhibited.

The graphite was purified by being stirred in fine powder into fused potash, and subsequent treatment with aqua regia by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid. The well washed powder was afterward compressed into blocks by hydraulic pressure, between platinum plates, and from these blocks the electrodes employed were cut. Notwithstanding the purification the photographs of the spark between these electrodes still showed very distinctly lines of magnesium and iron. This fact shows the extreme difficulty of getting rid of all impurity, and the caution which is requisite in any reasoning depending on the assumption of chemical purity in the materials employed. It is very possible that the magnesium and even the iron in this case may have been due to oxides of those metals in the floating dust of the laboratory, which we know always contains sodium compounds, and which at Cambridge—where the water, soil, and bricks contain sensible quantities of lithium—almost always show traces of that element.

The wave lengths of the strongest carbon lines were determined by means of a Rutherfurd diffraction grating having 17,296 lines to the inch. The measures were made in the following way: The collimator and telescope of the goniometer were first centered by the instrument maker's marks. The telescope was then more carefully adjusted for center by directing it on to a distant mark, taking the reading of the circle, turning the arm carrying the telescope through 180°, and reversing the telescope, whereby the mark was again brought into the field of view, and adjustments were then made until the mark had the same position on the cross wires in both positions of the telescope. The grating was next placed in position, and, after adjustment to the vertical plane, was brought very nearly at right angles to the axis of the collimator by turning it until the sodium D lines in the spectra of the second order were observed to fall at equal distances on either side of the collimator. The small photographic slide, containing the sensitive plate, fitted the telescope in place of the eye piece, and so could easily be turned about an axis, coincident, or nearly so, with the optic axis of the telescope. In taking a measurement of the position of a line the approximate wave length was first found by interpolating between the nearest cadmium or other lines of known wave length in photographs taken with calcite prisms. The telescope was then set to the angle corresponding to this approximate wave length for the spectrum of the fourth order. The lower half of the slit was closed by a shutter, and, the photographic slide having been adjusted for level, the plate was exposed to the light which came through the upper half of the slit, and gave an image of the lines in the lower half of the field. When this exposure was completed the photographic slide was turned round through 180° about the axis of the telescope, so as to bring to the top that part of the sensitive plate which had been before lowest. It was then exposed a second time, and thus two images of the same line were impressed on the plate which were necessarily at equal distances on either side of the point where the axis of the telescope met the plate. By a subsequent measurement with a micrometer under a microscope of the distance between the two images, and the conversion of this distance into angular measure, a connection was found, which was added to or subtracted from the reading of the circle to get the exact deviation of the ray producing the line under observation. Another photograph of the same line was next taken in the same way as before, except that the telescope was placed at the corresponding

* Abstract of a paper read before the Royal Society, March 9, 1882.

angle on the other side of the collimator. From the two angles thus found the wave lengths of the line was calculated. The process was repeated three or four times for each line, and the mean wave length thus found for carbon lines were 2297·4, 2478·4, 2508·7, 2511·6, 2836·3, and 2837·3. The numbers deduced from the different photographs of the same line differed from one another in the last figure only, so that we are justified in assuming the first four figures to be accurate in each case The wave lengths of the remaining lines were obtained by interpolation from measures of photographs taken with a train of two calcite prisms of 30° each, and one of 60°, on which the iron as well as the carbon lines were shown. The wave lengths of the iron line used in the interpolations were deduced from photographs taken with the grating in the same way as that above described for the carbon lines. The wave lengths thus formed for the remaining carbon lines are given in the table below.

In taking the photograph of the spark the induction coil was sometimes worked by a De Meritens dynamo-electric machine, and in that case the stream of sparks was not only extremely brilliant, but produced a deafening roar. Notwithstanding this character of the spark the photographs, when the spark was taken in air, between poles of purified graphite, showed, besides the carbon lines above described, the set of six cyanogen flutings in the blue very distinctly, and those between K and L, and those near N, strongly developed. On the other hand, when the spark was taken in carbonic acid gas, these flutings almost entirely disappeared, and would no doubt have disappeared entirely if the last traces of air had been removed from the apparatus.

TABLE OF CARBON LINES.

| Authors. | Color. | Wave Length. | Intensity. |
|---|---|---|---|
| Angstrom and Thalén. | Red | 6583·0 | 2 |
| | | 6577·5 | 1 |
| | Orange | 5694·1 | 4 |
| | | 5660·9 | 4 |
| | | 5646·5 | 3 |
| | | 5638·6 | 5 |
| | Yellow | 5379·0 | 6 |
| | Green | 5150·5 | 4 |
| | | 5144·2 | 3 |
| | | 5133·0 | 5 |
| | Indigo | 4266·0 | 1, diffuse. |
| Liveing and Dewar. | Ultra-Violet. | 2995·0 | 4, very diffuse. |
| | | 2968·0 | 5, " " |
| | | 2837·3 | 2 |
| | | 2836·3 | 2 |
| | | 2746·5 | 3, very diffuse. |
| | | 2733·2 | 6, " " |
| | | 2640·7 | 4, " " |
| | | 2541·5 | 6 |
| | | 2528·2 | 5 |
| | | 2523·6 | 5 |
| | | 2518·7 | 5 |
| | | 2515·8 | 4 |
| | | 2514·0 | 5 |
| | | 2511·6 | 2 |
| | | 2508·7 | 3 |
| | | 2506·6 | 5 |
| | | 2478·4 | 1 |
| | | 2297·4 | 3 |
| | | 3919·3 | 2, diffuse |
| | | 3876·5 | 4, " |

*Spectrum of Incandescent Carbon Filaments.*

We have also examined the spectrum of Swan's incandescent lamps. So long as the carbon thread is unbroken it emits a continuous spectrum, on which neither bright nor dark lines are visible. By gradually increasing the number of cells in the battery, until the thread gave way, we found at the instant of fracture, for a small fraction of a second only, that a set of flutings in the green appeared. In some of those lamps we observed, when the current was nearly as much as the carbon thread would bear without rupture, that a sort of flame appeared in the lamp. On examining the spectrum of this flame it gave the flutings of carbonic oxide very distinctly, and we made sure that they were those of carbonic oxide, and not those of hydrocarbons, by comparison with the bands of a Bunsen burner. Closer examination showed that this flame was strongest about the junction of the carbon thread with one of the conducting wires, and that on reversing the current it shifted from one wire to the other, and the wire about which it appeared was always the positive electrode In fact the flame was the glow of the positive pole attending a discharge of rarefied gas; when the resistance of the carbon thread became too great in proportion to the intensity of the current, the discharge began to occur through the rarefied atmosphere within the envelope of the lamp. The spectrum showed that this atmosphere contained carbonic oxide.

By interposing different flames between the incandescent lamp and the slit of the spectroscope we have been able to make some comparisons of the probable temperatures of the flames and filament. For this purpose a lens of three inches focal length was placed six inches in front of the slit, and an image of a horizontal part of the incandescent carbon thread formed by it across the (vertical) slit. The appearance in the field of view of the spectroscope was a narrow continuous spectrum extending all across the field. When a flame was interposed between the lens and the slit, the bright lines of the flame were seen above and below the narrow continuous spectrum, and in some cases were continued across it or were seen reversed upon it. When the flame was that of a Bunsen burner in which was a platinum wire with sodium carbonate, the yellow sodium lines were seen bright above and below the continuous spectrum of the carbon thread, but reversed where they crossed it. When lithium was substituted for sodium in the flame, the red lithium line was also seen bright above and below the continuous spectrum, but reversed where they crossed it. When an oxyhydrogen jet was substituted for the Bunsen burner, and sodium carbonate held in it, the yellow sodium lines were not only bright above and below the continuous spectrum of the carbon, but showed as bright lines where they crossed it; in fact they were conspicuously brighter than the carbon. When coal gas was substituted for hydrogen in the jet the same appearance presented itself, only the sodium lines were not so much brighter than the carbon as they were before. Fifty Grove cells were used with the incandescent lamp, which were as many as could be used without danger of rupturing the threads. When barium chloride was held in the hydrogen flame, fed with only a little oxygen, the bright green line of barium (wave length 5534) was well seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When a flame of cyanogen burning in air was interposed, the bright bands of that flame could be seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When sodium carbonate was held in this flame the yellow sodium lines were seen feebly reversed where they crossed the spectrum of the incandescent lamp. We infer from these experiments that the emissive power of the carbon thread for light of the refrangibility of the D lines is nearly balanced by that of sodium at the temperature of the flame of cyanogen burning in air, but is sensibly less than that of sodium at a temperature of a jet of coal gas and oxygen, much less than that of sodium in the oxyhydrogen jet. This seems to render it probable that the temperature of the incandescent thread is not far different from that of a cyanogen flame burning in air, but is less than that of an oxyhydrogen flame, though this does not necessarily follow from the experiments, inasmuch as the radiation of the sodium is so much more limited as to range than that of the carbon. When a Bunsen burner or a gas blow-pipe flame was interposed between the lens and slit, no reversal of the hydrocarbon bands could be seen. When magnesium was burnt between the lens and slit, the magnesium lines (*b*) were seen bright, eclipsing the carbon. Possibly the smoke of magnesia may have considerably helped to eclipse the light of the carbon.

## THE DEODORIZATION OF IMPURE SPIRITS BY ELECTROLYSIS.

PROCESS OF MESSRS. NAUDIN AND SCHNEIDER.

THE eminent French chemists, Messrs. Naudin and Schneider, have invented and patented a process for deodorizing empyreumatic or rank spirits by electrolyzation, which has given most excellent results, and a description of which we translate from a pamphlet recently published by one of the authors. The rectification of impure spirits (or *flegmes*), with a view to obtaining alcohol of good flavor, has been performed up to the present time through processes which, in most cases, left much to be desired. Distillation by columns *only* can not possibly yield *neutral* alcohols, that is to say, those entirely deprived of bad flavor; and spirits from molasses of beet are found especially difficult to treat. Bone-black, which was very much in favor some years ago, has had to be given up on account of the cost of keeping it in proper condition, and also because its pores always retain appreciable quantities of empyreumatic matters which are soluble in alcohol, and give it a bad taste. Wood charcoal, which has also been used as a deodorizer, soon becomes inert. Other unsuccessful modes of deodorization have been tried with coke and olive oil. There have likewise been put in practice for the last fifteen years numerous chemical processes. Oxidizing agents destroy the bad flavors, wholly or in part, but they possess the drawback of giving rise to other flavors. Deodorization by aerification has rendered a certain amount of service, but that is accompanied by a loss of alcohol. Finally, the use of alkalies, as usually practiced, has given very poor results.

For all such processes, Messrs. Naudin and Schneider have substituted hydrogenization by means of a metallic couple in a neutral liquid. If we plunge a strip of zinc into a solution of a salt of copper it becomes covered with a metallic deposit. When all the copper has been deposited, it constitutes a zinc-copper couple, and one in which the copper is in a very divided state. Such a couple decomposes water with a disengagement of hydrogen. It may, consequently, easily act in neutral liquors, and it forms a powerful hydrogenizing agent. Now, if we put impure spirits, marking 40° to 60° of the alcoholmeter, in contact with a couple of this kind, the hydrogen will be absorbed, and both odor and taste will disappear from the liquid. When such hydrogenized spirits are rectified by the usual apparatus, they are found to show an increase of from 25 to 30 per cent. of good flavored alcohol over the yield obtained by old methods.

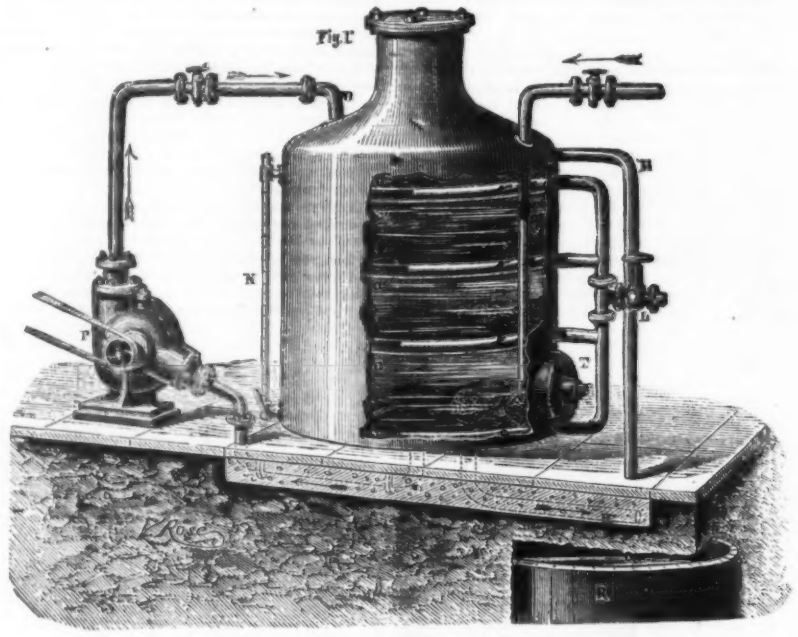


FIG. 1.—APPARATUS FOR HYDROGENIZING IMPURE SPIRITS.

Of the accompanying cuts, Fig. 1 represents an installation of Messrs. Naudin and Schneider's apparatus for industrial purposes. The zinc, in the form of clippings, is put into a vessel of wood, copper, or iron, and spread in layers, *a*, *a'*, *a''*, *a'''*, of 0·15 m. to 0·20 m. thick on double-bottomed wooden partitions pierced with holes. A circulation of hot

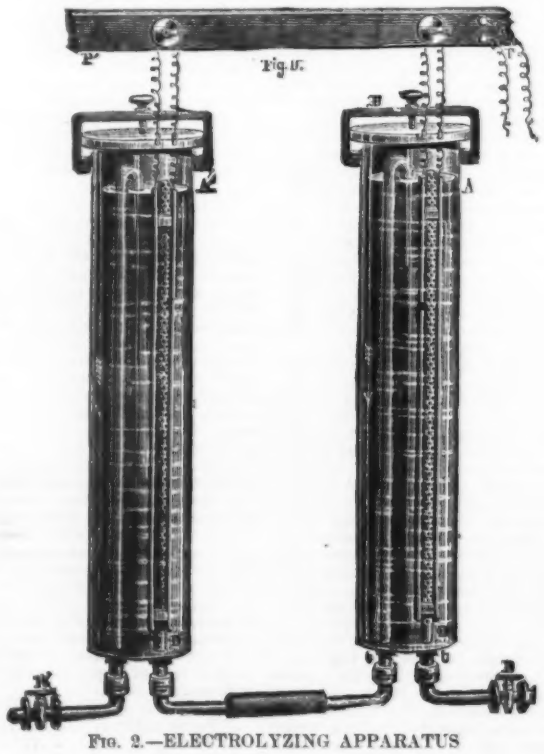


FIG. 2.—ELECTROLYZING APPARATUS

water is kept up through a worm, *e*, *e'*, *e''*, *e'''*. The spirits enter, as shown by the arrow, through the tube to the right, and, after hydrogenization, pass out to the rectifier through the discharge tube, H The disengaged hydrogen, charged with alcoholic vapors, bubbles into the receptacle, R, containing the ordinary spirits, through the tube, M. For

about an hour the pump, P, sucks the spirits in the direction of the arrows, and forces them to the upper part, D, of the vessel.

In order to form the zinc-copper couple, a 5 per cent. solution of sulphate of copper is pumped into the vessel. In about two hours the solution will have become decolorized through the complete precipitation of the copper, and it is only necessary then to draw off the solution of sulphate of zinc from the couple, and to fill up the vessel with spirits.

The inventors have tried the hydrogenization of crude spirits of beet (which should not be confounded with the spirits from beet molasses), and found that it effected a great improvement in them; but, after rectification, it was noticed that the alcohol had a slight beet taste, which depreciated its commercial value. To make their results more complete, Messrs. Naudin and Schneider have therefore devised a method of electrolyzing the impure alcohols by generators of electricity, and this forms the second part of their process.

The *modus operandi* is as follows: The hydrogenized spirits, after a sufficient length of contact with the zinc-copper couple, are acidulated with one-thousandth part of sulphuric acid, and led into a special voltameter, which will be described further on. Here, under the influence of the electric current decomposing the water normally contained in

FIG. 3.—ELECTROLYZER MOUNTED.

the spirits, they undergo an oxidation which destroys the very last traces of bad flavor. The final saturation of the acidulated spirits by zinc or iron brings about also a sure destruction of such bodies as might have possibly escaped the zinc copper pile or an electrolysis by machines.

The electrolyzing apparatus, Fig. 2, consists of a cylindrical glass vessel, A, provided with two tubings *t*, *t'*, at the bottom. The top of this vessel is hermetically closed by a glass disk. The tube, B, which lets in the spirits, is pierced with holes throughout its entire length, and is closed at the top and supported at a short distance from two pieces of platinum (figured black in the cut) which represent the two electrodes of the current distributed by commutators on the support, P, P'. The electrodes are connected with the current by wires traversing the glass disk. The flow of the spirits is regulated by the cocks, R, R'. The return tube, *c*, allows the gases produced to escape with the liquid current, and to bubble from one voltameter to the other. The number of voltameters that are united depends on the intensity of the current to be produced. Fig. 3 gives a perspective view of a three voltameter electrolyzer that may be coupled with another battery.

Fig. 4 shows a plan of installation of this new process for a daily production of 100 hectoliters (about 220 gallons) of 100° alcohol, corresponding to a treatment of 200 hectoliters of impure spirits of 50°.

The Naudin-Schneider process is by no means an untried one, but has for some time past been in practical use. Since the 15th of March, 1881, there have been treated by this method at the works of Mr. G. Boulet, near Rouen, 200,000 liters of alcohols derived from three sources—molasses, maize, and beetroots. The alcohols thus obtained have a value fully equal to that derived from grain. The effect of the hydrogenization is to transform into alcohols the aldehydes contained in the empyreumatic spirits.

The question of the purification of bad flavored alcohols has assumed a high importance in France, where it has become customary to believe that the only neutral alcohols were those from Germany; so the number of more or less efficacious processes that have been devised for the purpose is considerable. Among the more important of these, in addition to the one under consideration, may be mentioned the ozonizing process of Eisemann, and the process by congelation invented by M. Raoul Pictet.

## SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

THE following are the relative sensibilities of the principal reactions:

1. Metallic zinc.—One-sixth milligramme of gallium is easily separated without sensible loss from a liter of liquid, even in presence of many foreign substances. At this degree of dilution we are still far from the limit of the sensitiveness of this method. The difficulty of procuring pure zinc unfortunately restricts in practice the use of this metal in delicate analyses.

2. Cupric hydrate.—The same sensitiveness as zinc.

3. Copper and cuprous oxide.—The same exactitude as the two former. Copper and its oxides being easily obtained in a state of purity are to be recommended whenever their use is practicable.

4. Arsenic sulphide.—Very sensitive, but perhaps slightly inferior to the three former reactions. It withdraws the greater part of 1-6th milligrm. of gallium from a liter of liquid.

5. Manganese sulphide.—With 1-6th milligrm. gallium per liter, we obtain, at the end of the operation, the ray Ga *a* 417, but less bright than if we had made use of arsenic sulphide.

6. Potassium ferrocyanide.—1-205,000th of gallium is precipitated and collected upon a filter without sensible loss; we may therefore go further.

7. Boiling after supersaturation with ammonia.—This process gives rise to losses, which seem to range between 1 and 1·5 mgrm. per liter. In a rigorous analysis, the ammonia is expelled in the water bath, or the mixture is boiled in a flask placed in a slanting position to prevent loss by spirting.

8. Carbonate of lime, hot, then ammoniacal ebullition of the hydrochloric solution of the mixture of calcium carbonate and gallium sesquioxide.—The losses, slightly higher than those in the preceding method, rise to 1·5 milligrms. per liter of the original liquid.

9. Calcium carbonate, hot, after reduction of the liquid with sodium sulphite, then ammoniacal ebullition of the hydrochloric solution of the mixture. The loss is about 1·5 milligrms. per liter.

### QUANTITATIVE ANALYSIS OF THE SALTS OF GALLIUM.

*Separation from Cæsium, Rubidium, Potassium, Sodium, Lithium, and Ammonium.*—When the proportion of gallium is not very small, the simplest method is to supersaturate the hydrochloric solution with ammonia, and to boil until a litmus paper, previously placed in the liquid, takes a distinctly red tint. Water must be added to make up for the loss by evaporation. The gallium oxide is received upon a filter, washed, dried, and ignited. To separate the traces of gallium entangled in a considerable mass of alkaline salts, the boiling solution is treated with cupric hydrate. The mixture of gallium sesquioxide and cupric oxide is redissolved in a decided excess of hydrochloric acid; the copper sulphide, which is then thrown down by sulphureted hydrogen, does not carry gallium with it, and the liquid, concentrated to a small bulk, is supersaturated with ammonia, and then boiled for a long time.

*Separation from the Alkaline Earths.*—If the gallium is moderately large in quantity it may be at once precipitated by ammoniacal supersaturation, followed by prolonged boiling; the alkaline earthy oxides remain in solution. Traces of gallium sesquioxide, mixed with much of the salts of barium, strontium, or calcium, are separated by means of cupric hydrate. The baryta and the bulk of the strontia and lime may also be precipitated by sulphuric acid from a liquid more or less alcoholic. After evaporation of the alcohol and concentration to a small bulk, the gallium is recovered by ammoniacal ebullition, or by cupric hydrate, according to the degree of exactness required. When the former method has been used the precipitate must be ignited strongly to expel completely any traces of sulphuric acid.

*Separation from Magnesia.*—Prolonged ebullition of a solution supersaturated with ammonia succeeds well. The process with cupric hydrate is suitable where there are small quantities of gallium along with much magnesia.

*Separation from Alumina and Chromic Oxide.*—The most convenient process is to precipitate the gallium with ferrocyanide from a very acid hydrochloric solution, containing at least from a fourth to a third of its bulk of concentrated acid. When the gallium is in small proportions (less than 1-100,000th), it must be allowed to stand one day or two days for the precipitate to form. It is then received on a filter, washed with water containing a fourth to a third of its bulk of hydrochloric acid. The filter is dried at a gentle heat and ignited. The result is a mixture of the oxides of gallium and of iron, which are separated, as will be explained in the course of these researches. The almost inevitable formation of a little Prussian blue in the highly acid liquid presents no inconvenience, and merely increases the proportion of ferric oxide to be afterward separated from the gallium oxide. Ferrocyanide enables us to separate and determine gallium mixed with 2,000 times its weight of alumina or chromic oxide. Nevertheless, slight traces of gallium diffused among enormous masses of alumina or chromic oxide, may escape the action of the ferrocyanide. They are collected then by "entanglement in metallic sulphides (those of zinc, arsenic, or manganese) formed in alkaline or acetic solutions." Precipitation with sulphureted hydrogen in a solution containing ammonium acetate, free acetic acid, and arsenious acid seems preferable. The galliferous arsenic sulphide, previously washed with sulphureted hydrogen water containing a little acid ammonium acetate, is treated with aqua regia, and evaporated almost to dryness in presence of an excess of hydrochloric acid to expel nitric acid. The arsenic acid is then reduced by sulphurous acid or an alkaline sulphite, diluted with water strongly charged with hydrochloric acid, and treated with sulphureted hydrogen. The arsenious sulphide precipitated is washed with sulphureted hydrogen water containing hydrochloric acid. The gallium remains in the liquid, and is separated by concentration to a small bulk, and boiling after supersaturation with ammonia.—*Comptes Rendus.*

## NOTES ON THE DETERMINATION OF PHOSPHORIC ACID.

By CARL MOHR.

JOULIE'S method for determining the compounds of phosphoric acid soluble in ammonium citrate prescribes the volumetric estimation of the ammonium-magnesium phosphate with a solution of uranium. The precipitate is to be dissolved in dilute nitric acid, the solution slightly supersaturated with ammonia, and the precipitate redissolved in dilute acetic acid. This method of treatment introduces into the solution too large a quantity of neutral ammoniacal salts, which are known to have a retarding effect on the appearance of the final reaction with potassium ferrocyanide. It is also known that large quantities of neutral calcium and alkaline salts have the same disturbing influence, rendering the results always too high. It is hence of great importance in determinations with uranium, to keep within the boundaries which were observed in standardizing the solution. This state of affairs has led the author to obtain a double standard for his uranium solution; the one for solutions poor in lime, such as superphosphates, Mejillone's guano, etc.; and the other for solutions rich in lime, like the marl phosphates. The differences are not very considerable, but still enough to have a noticeable effect in the result. Thus for superphosphates 1 c. c. of the uranium solution represented 0·0041 phosphoric acid, but for marl phosphates only 0·0039 grm.

The author has undertaken to determine, by a series of comparative experiments, the influence of combined ammonia in titrating ammonia magnesium phosphate with uranium and also to decide in how far this ammonium compound has

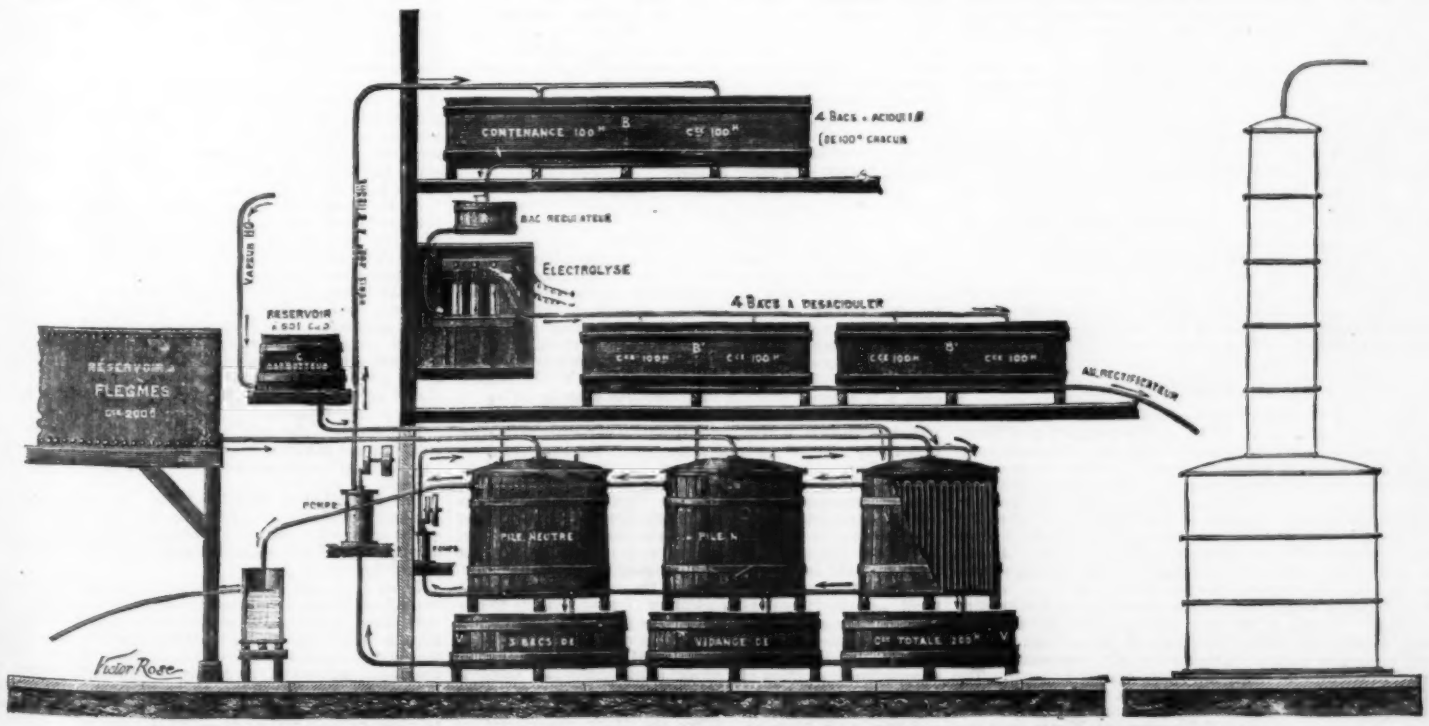



FIG. 4.—SECTIONAL VIEW OF PLANT FOR A DAILY MANUFACTURE OF 220 GALLONS OF RECTIFIED ALCOHOL.

a retarding action upon the appearance of the final reaction. For this purpose he prepared a solution of pure calcium phosphate in dilute nitric acid. In one series of experiments portions of 10 c. c. of this solution were mixed with sodium acetate and titrated with uranium. In the second series the lime was thrown down with ammonium oxalate, and the phosphoric acid with magnesia. In both series equal quantities of uranium solution would be consumed if the ammonium compound had no disturbing influence.

In direct titration the average quantity of uranium solution consumed was 9·46 c. c. If the phosphoric acid was precipitated as ammonio-magnesium phosphate, dissolved and titrated, the average was 9·37.

These experiments prove that there is a sufficient agreement between the two processes if in using the second or indirect method the precaution is adopted of allowing the precipitate and filter to stand for some time in a warm place, so that the free ammonia of the washing water may evaporate.

In vol. xix., page 150, of the *Zeitschrift*, the author has communicated a process for determining phosphoric acid with uranium in presence of iron. This process he has since then frequently proved, and can recommend it to technical analysts as accurate. The procedure suggested is found tedious and disadvantageous, so that he has felt induced to adopt a modification. In his original memoir he proposed to throw down the ferruginous solution of phosphate partially with uranium, and then to add so much potassium ferrocyanide as suffices for transforming the ferric phosphate. This transformation is often incomplete if but little iron oxide is present, as in animal charcoal and guano. It is hence every way better to throw down the iron with potassium ferrocyanide before precipitating the phosphoric acid. Filtration is in either case unnecessary. Instead of precipitating the iron with pulverized potassium ferrocyanide, as directed in the author's first memoir, he prefers a 5 per cent. solution, which is introduced into a small bulb pipette drawn out below to a fine orifice. To regulate the outflow of the liquid a glass tap is adapted below the bulb.

When precipitating a ferruginous phosphatic solution it is needful to ascertain previously how many drops of the ferrocyanide solution are necessary. The solution is dropped in till a drop of the liquid gives a faint reddish or brown coloration. To a second portion there are added one or two drops fewer, and it is ascertained by a second test with uranium solution if the precipitation point has been reached. It is necessary to count the drops exactly. In metallurgical or mining establishments where ores of the same class are always examined, a single determination of the number of drops is sufficient to show how much ferrocyanide solution is always to be used for the precipitation of the iron.—*Zeitschrift für Analyt. Chemie.*

## A NEW REAGENT FOR NITROUS ACID.

By DR. A. JORISSEN.

IF nitrous acid is allowed to act upon an alcoholic solution of rosaniline, the liquid, according to Max Vogel, is colored at first a splendid violet, then a fine blue, which passes into a dark green, then into a yellowish green, and ultimately into a reddish yellow.

Although other chemists who have been engaged with researches on the constitution of rosaniline have made similar observations to those of Vogel, it does not appear that any one has proposed to apply this reaction to the detection of nitrous acid. Rosaniline may, however, be used for the detection of traces of nitrous acid, but it is advisable to use a solution in glacial acetic acid in preference to one in alcohol.

If we dissolve 0·01 grm. magenta in 100 c. c. glacial acetic acid, and if 2 c. c. of this solution are placed in a small porcelain capsule, and a trace of solid potassium nitrite be added, the phenomena described by Vogel may be observed. The liquid turns successively violet, blue, green, and finally yellow. The nitrates are without action upon the reagent. If there be added to the test-liquid free mineral acids, the mixture takes finally a yellow color, but this is due to the formation of a tri-acid salt of rosaniline, and the characteristic red color of rosaniline can be reproduced by the addition of water. When the change of color has been occasioned by nitrous acid the original color cannot be restored by the addition of water, but the liquid remains yellow.

If it is desired to detect a nitrite in a liquid it is concentrated, or by preference evaporated to dryness. When cold, a suitable quantity of the reagent is added, when the characteristic play of colors is produced if a nitrite be present. The evaporation to dryness serves to render the reaction more sensitive, as it succeeds better the more concentrated the acetic acid.

In searching for minute traces of nitrous acid, the quantity of magenta dissolved in the glacial acid may be proportionally decreased by, *e. g.*, mixing 1 c. c. of the reagent, as described above, with 9 c. c. of glacial acetic acid.

The author has shown experimentally that the new reagent may be used for the detection of nitrous acid in natural waters in Fresenius's method of distilling with glacial acetic acid. For this purpose, 1 c. c. of a solution of 0·5 grm. potassium nitrite in 1 liter of water was added to 100 c. c. of water. This liquid, which contained 0·0005 grm. of the nitrite, was mixed with acetic acid and introduced into a small retort connected with a receiver containing a mixture of 9 c. c. glacial acetic acid and 1 c. c. of the test liquid (the solution of 0·01 grm. magenta in 100 c. c. glacial acetic acid). A few drops of the distillate sufficed to produce the above-described change of colors in the receiver.—*Zeitschrift für Analytische Chemie.—Chem. News.*

## NITRIC ACID IN SOILS.

AT a recent meeting of the London Chemical Society, Mr. Warington read a paper "On the Determination of Nitric Acid in Soils." As to the taking a sample of the soil, a detailed description of which the author promises to give on a future occasion, it is important to sample the subsoil as well as the surface, and to take the samples after dry weather. Thus Boussingault, August 9, 1856, found that after dry weather the surface soil of a kitchen garden contained nitrogen as nitrates=29·2 per million; a few weeks after, August 29, rain having fallen, the nitrogen=1·2 per million; October 10, after dry weather, the nitrogen was 41·3 per million. It is necessary to dry the sample speedily, else nitrification proceeds. Drying at 100° may occasion a loss of nitrates in proportion to the wetness and mass of the soil and its richness in organic matter. Drying at a high temperature also greatly increases the soluble organic matter in a soil. The plan adopted by the author is to break up the soil to small pieces, place these in paper trays, and dry in a stove at 55°, (the temperature at which Schloesing and Müntz state that nitrification ceases). Soils thoroughly dried in dry air seem to undergo a very little change by keeping. The method commonly used to prepare an extract of the soil is to shake 500 or 1,000 grms. of soil with its own or twice its own weight of water, and take a known portion of the solution for analysis. This method is tedious, and yields a very dilute and turbid extract. The author extracts 200 to 500 grms. of dry powdered soil with cold water, on a vacuum filter, until 100 c. c. have passed through. This extraction takes from ten to forty-five minutes, and all the soluble salts can be extracted with the utmost ease. Thus 7 lb. of dry powdered soil, in a column eight inches deep, were extracted with cold water. All the chlorides, and 99 per cent. of the nitrates present, appeared in the first 150 c. c. of extract. In dry soil, if free from fissures, a descending column of water dissolves all soluble salts, at its lower edge, and pushes the solution before it until an area of discharge is reached: thus the salts are obtained in the form of a concentrated solution. If, on the other hand, wet soil is employed, the whole of the water must be expelled to obtain all the soluble salts present, and a large and dilute extract is therefore obtained. For the analysis of the extract, the Crum-Frankland process was at first employed; the greater part of the organic matter has to be removed by treating the highly concentrated extract from the soil with strong alcohol, the filtrate being evaporated to dryness and dissolved in a small quantity of water. If a drop of dilute hydrochloric acid be introduced with the purified soil extract into the shaking tube, to make the action on the mercury more energetic, very fair results, if the amount of nitric acid be not too small, may be obtained. The determination of the nitric acid is now made by a modification of Schloesing's method, the nitric oxide being measured. When this method is used no purification of the soil extract is required, and much larger quantities of nitrate may be operated on. The results obtained by this method are rather higher than those yielded by the Crum-Frankland process.

The President said tha the determination of the nitrogen in soil was of the utmost importance, but until the method of collecting a true sample of the soil was introduced, it was difficult to know what the results obtained really represented. When at Rothamsted a balance of the nitrogen given to the land as manure, and the quantity present in the crops, was first struck, it was found that only one third of it could be accounted for in the crops. It was suggested that the excess accumulated in the soil, but it has been proved that this accumulation varied not with the quantity of manure applied, but with the growth on the soil; with a bad growth no accumulation took place. This question as to the ultimate fate of the nitrogen lost was one of the greatest importance in agricultural chemistry.

## CRYSTALLINE ZIRCONIA.

By A. M. LEVY and L. BOURGEOIS.

ON attacking zircon at a high temperature with sodium carbonate, we obtain, after cooling the fused mass and lixiviating with hot water, a crystalline powder, very hardly attacked by acids and composed of zirconia, sensibly pure. A microscopic examination of the mass shows that the crystals exist there previously to lixiviation. Zirconia therefore crystallizes in an excess of melted sodium carbonate. These crystals appear in two forms according to the temperature and the quantity of sodium carbonate employed. On operating with a weight of the flux ten times that of the zircon, and raising the mixture to white redness, if the quantity of zircon does not exceed 0·01 grm., there are formed especially rectangular crystalline aggregations. Their most perfect type consists in the association of six crystals, grouped according to the quaternary axes of a cube. Each element is a small transparent prism with a terminal point of about 73°. These delicate productions may also be obtained from pure zirconia. Analysis shows no trace of silica, and only 1 to 2 per cent. of soda, which appears to be due to impurities. Platinum is always present up to 10 per cent., and is due to the corrosion of the crucible. The compound which it forms is incorporated as an isomorph with the zircon and colors the crystals yellow. When this coloration is strong, the phenomena of polarization become very sensible.

On operating at bright redness and with a weight of sodium carbonate twice that of the zircon, the zirconia crystallizes after a few minutes in the flux. After lixiviation in hot water we obtain transparent hexagonal lamellæ. The elementary forms of these hexagons are totally different from the former kind. These phenomena appear similar to those presented by tridymite. The two forms of zirconia obtained appear incompatible with each other. The zircon of Espailly, treated with twice its weight of sodium carbonate at a bright red heat for five minutes, yields, after cooling and lixiviation, a weight of hexagonal lamellæ of zirconia representing approximately the total contained in the mineral. 0·005 grm. of zirconia suffices to yield one or other of the crystalline products, or a mixture of the two. We have here a micro-chemical reaction of remarkable delicacy and precision, enabling the presence of zirconia to be easily detected. Yttrium, niobium, tungsten, titanium, and tantalum yield nothing similar.—*Comptes Rendus.*

## SEPARATION OF NICKEL.

By DR. A. JORISSEN.

THE action of reducing agents upon nickel hydroxide is well known to be much more energetic than upon cobalt hydroxide, and upon this circumstance there have been founded several methods for the separation and determination of nickel and cobalt This difference in permanence is especially shown with potassium cyanide, which can be advantageously used for the separation of small quantities of nickel in presence of cobalt. While, in fact, even a few drops solution of potassium cyanide suffice to reduce and dissolve in the cold a considerable quantity of nickel hydroxide, a very small quantity of cobalt hydroxide is scarcely affected by a large excess of the same reagent. This difference in the behavior of the two oxides can be advantageously used for the detection and separation of nickel in presence of much cobalt. The two hydroxides are precipitated by the successive application of soda-lye, and of a quantity of bromine sufficient to convert all the nickel and cobalt into oxide. One or two c c. of solution of potassium cyanide are then added, without previous filtration, and the mixture is well shaken in the cold. It is then filtered, and the filtrate, after addition of *aqua regia*, is evaporated to dryness. On redissolving the residue in water, there is obtained a solution of nickelous chloride, which shows the characteristic reactions of nickel very distinctly. The successive application of ammonia and ammonium sulphide is particularly recommended, which gives a dark-brown liquid. Or the solution may be treated first with soda-lye and then with bromine. When the black precipitate has thus been formed, two or three drops of potassium cyanide are added. The precipitate disappears very quickly in the cold and a clear solution remains. It must be noted that if a solution of very much nickel and little cobalt is treated in the manner above described, the latter enters into solution.

If two solutions of equal quantities of cobalt are submitted to the above-described process, the one containing in addition a ten-fold proportion of nickel, and if in each case there is added an equal number of c. c. of solution of potassium cyanide, it will be observed that the solution containing nickel and cobalt is almost entirely decolorized, while the other still contains black flocks in suspension. If a small quantity of potassium cyanide is used, it is always possible to separate a quantity of nickel sufficient for recognition.—*Zeitschrift für Analytische Chemie.*

## THE ROSANILINE QUESTION.

By A. PABST.

IT has long been known that commercial rosaniline, as extracted from the product of the reaction of arsenic acid with aniline and toluidine, is a mixture of two nearly allied bodies. M. Rosenstiehl, in an investigation published about twelve years ago, announced three such bodies, but since the recent researches of Fischer only two are admitted—para-rosaniline, isomeric with the mauvaniline of Girard and De Laire, derived from a mixture of aniline and para-toluidine; the other, ortho-para rosaniline, is formed from aniline and the two toluidines. These two rosanilines co-exist in the hydrochlorate sold under the name of "fuchsine," but one of them, ortho-para-rosaniline, is only proper for the manufacture of rosaniline blue, the other giving merely a grayish violet product. Hence manufacturers have long sought to separate them, utilizing the ortho-para for blue, and converting the para-rosaniline into magenta. The first process, employed as far back as 1855 by Girard and De Laire, consists in leaving the acetates of the bases to settle; that of para-rosaniline remains sirupy, and may be dried in amorphous crusts; that of ortho-para-rosaniline crystallizes, and may be separated by draining. The solutions of the two rosanilines are closely alike; that of para-rosaniline inclines a little more to the violet, but in dyeing the shades obtained are practically identical. M. Monnet boils for two or three hours the commercial magenta with moist rosaniline, prepared by precipitating a portion of the same magenta with an alkali; the para-rosaniline displaces the ortho-para compound, and forms a soluble salt, while the other becomes free and remains upon the filter. After boiling in pure water it is washed in hot ammoniacal water, and serves then for the manufacture of blue. M. C. Girard gives two other methods of separation founded upon the solubilities of these bases. M. Fischer thinks that these two rosanilines are identical with the red bodies obtained by oxidizing the leukanilines, which these chemists have obtained synthetically, setting out from triphenyl-methan and ortho-cresyl-diphenyl-methan. The author has expounded the ingenious theory which arranges the artificial colors in five groups: The substituted phenols, anthracene, triphenyl-methan, comprising rosolic acid, rosaniline, and its derivatives, malachite green and the phthaleines, which are the link between tripheny-methan and anthracene; the indulines and saffranines and the azo-compounds. The rosaniline may be obtained by the oxidation of a mixture of aniline and toluidine; by the oxidation of pure aniline upon stannic chloride; by the action at 150° of nitrosyl chloride upon aniline mixed with toluidine, and by the action of aniline upon nitrobenzol in presence of certain chlorides. It is very probable that rosaniline, when transformed into leuk-aniline by reducing agents, undergoes a transformation, leuk-aniline and rosaniline not having the same constitution. The author does not see why there may not exist several leukanilines and several rosanilines, with several rosolic acids corresponding.

## ACTION OF SULPHURETED HYDROGEN.

By M. H. BAUBIGNY.

ON a former occasion, the author called attention to the influence exerted by the comparative weights of acetic acid and nickel oxide upon the formation of nickel sulphide when an acid solution of nickel acetate is treated with sulphureted hydrogen. A fact of the same nature may be verified with nickel sulphate. The results obtained under conditions otherwise alike are independent of the state of concentration of the metallic solution.

With zinc, as is said by Berzelius, and as the author has verified, the precipitation ceases when the liquid becomes acid up to a certain point. With nickel nothing of the kind occurs, and hence the quantity of nickel sulphide, formed by sulphureted hydrogen, is a function of the duration of the experiment.

These results are independent of the state of saturation of the solution by the sulphureted hydrogen gas, for the precipitation presents the same properties if the metallic solution is saturated at 0°, or at 30°, at which latter temperature the solubility of sulphureted hydrogen in water is about half what it is in the same liquid at 0°. The precipitation is merely less rapid.

As the weight of nickel sulphide formed increases with the duration of the experiment, it results that the quantity of sulphuric acid set at liberty increases also, and as the reaction takes place, other things being equal, with a dilute or concentrated solution of nickel sulphide, we may believe that the formation of the sulphide is always independent of the weight of the free acid to the weight of the undecomposed sulphate. The foregoing observations, if thus interpreted, do not lead to an exact conclusion, for this progressive precipitation of the sulphide under the conditions laid down above is only due to a secondary reaction in which the nickel sulphide formed intervenes by forming a hydrosulphate of the sulphide.

The action of the sulphureted hydrogen under the above conditions is annulled as soon as the solution contains free sulphuric acid equal in weight to one-fourth of the acid of the salt.

The formation of nickel sulphide by sulphureted hydrogen and nickel oxide is a function of the ratio of the weights of the acid and of the metal present, and not of the relative acidity of the liquid—*i. e.*, the weight ratio of the free acid and of the water.

There is in this fact a lesson of great analytical importance from which the author has derived advantage for more than three years in the separation of nickel and zinc. For zinc, as will be shown on a future occasion, the precipitation of the sulphide is a function of the relative acidity of the liquid, and not of the relative weights of acid and metal present, so that by diluting the solution of zinc in proportion to the quantity of free acid, it may be precipitated as sulphide entirely and alone.—*Comptes Rendus.*

## PROCESS FOR PRINTING ANILIN.

A COMPANY was formed some time ago in London, to work the new and singular process of White and Anderson for printing many colors in one operation. The anilin colors are used in this process. They are previously dissolved in spirit mixed with pyroxylic acid or water. A gum solution or albumen is then added in order to fix the colors, and the whole dried in a stove. The dry colors so obtained are broken up, powdered, and mixed with the following composition :

| | Parts. |
|---|---|
| Mutton fat | 50 |
| Bleached beeswax | 7½ |
| Spermaceti | 7½ |
| Paraffin | 4 |
| Turpentine | 40 |
| Poppy oil | 5 |
| Boiled linseed oil | 9 |

The whole well stirred while still hot and liquid in the necessary proportions to give the desired shade. When cold the mass can be easily cut according to the outline of the patterns to be printed by means of a circular iron ribbon like a bench saw. For instance, if a pattern is wanted with ornaments in the form of a spiral on blue ground, with the center of a dark gray and the outside of light gray, then a dark gray block of the mass prepared as above is taken and cut in the cutting machine according to the pattern. This spiral is placed on a mould, and the hot composition for light gray is poured round, and when the mass is cold it is cut according to the light gray pattern required, then brought again into the mould or frame, where the blue composition for the blue ground is poured. When the pattern is complete the blocks are put into a frame, and the surface made perfectly level all over. In order to print with these blocks it is only necessary to apply them to the goods which have been previously wetted with turpentine, and to pass underneath a pressure roller. To extract the fatty bodies the printed goods are passed through sawdust, impregnated with naphtha, benzine, or petroleum. The goods are finally steamed, washed, and dried in the ordinary way.

## PROTEINE MATTERS FOR PRINTING.

M. EMILE DE PORTHEIM is the inventor of a process for obtaining proteine matters which are solubie, neutral, or slightly alkaline, and which only coagulate under the influence of heat. The proteine matters obtained by this process are intended to be specially used in the manufacture of printed goods as substitutes for albumen. These matters are: fibrin, casein, gluten, egg or blood albumen, which has become insoluble or coagulated. One hundred parts of one of the above stuffs are dried and ground together with about four parts alkali, and the mixture then dissolved in water by slightly heating. If the solution obtained is alkaline, it is neutralized by the addition of hydrochloric acid. When casein is used, it is advantageous to heat till it boils. When albumen, which has been rendered insoluble, is treated, the mixture is heated, and a coagulation of chloride of lime is added in order to obtain complete coagulation, and then it is dissolved in alkali without boiling. Gluten is purified in the following manner: It is liquefied by being exposed to air for some days, and is then saturated with carbonate of soda, washed, and dissolved in alkali. The solutions thus obtained are evaporated and dried, like ordinary egg albumen. Before using these solutions for printing, an addition is made of four per cent. chloride of lime. Other soluble compounds of calcium can be used, or those of barium, strontium, and magnesium.

## FERMENTATION OF THE PROTEIC MATTERS.

By A. GAUTIER and A. ETARD.

AT the outset of the experiments the muscles of beef and of horse-flesh were acid and inodorous. After some days, even when the matter was entirely protected from vibriones, the muscular matter gave off an acid odor, and without disintegration emitted a clear sirupy liquid, which seemed to result from the digestion of the muscular flesh due to a peculiar ferment. This liquid, analogous to a thick serum and almost colorless, contains 21 to 22 grms. per liter of albumen, coagulable by heat, and a very minute proportion of casein. In this medium the lactic and butyric fermentations were set up under the influence of large three or four-jointed bacilli, of eight-jointed bacteria, and of movable granulations. The gases given off were carbonic acid, nitrogen, and hydrogen, the two former of which increased from the seventh to the twenty-sixth day, while the latter decreased to a trace. There was a mere trace of sulphureted and phosphureted hydrogen, but no hydrocarbons. With the liberation of nitrogen the true putrid fermentation sets in. The great bacteria and bacilli disappear, and are succeeded by small bacilli, and with punctiform ferments, which attack the albuminoid molecule, disengaging carbonic acid and ammonia. The great mass of the molecule passes into the state of leucines and leuceines, accompanied by a small quantity of phenol, scatol, indol, and, according to the author's researches, of carbylamines and ptomaines.

## SYNTHESIS OF VARIOUS ORGANIC COMPOUNDS.

IN researches on galvanic polarities, one of the authors had observed that coke, charcoal, or graphite, under the action of the current, is disaggregated. While the electrolyte is blackened more or less according to its nature and that of the carbon, the gas evolved at the positive pole was below the normal volume. The immediate object of the present researches was to ascertain what became of the oxygen. They experimented with graphite, coke, and wood charcoal, purified by treatment with chlorine at high temperatures. With coke or charcoal as positive electrode, and distilled water as an electrolyte, they had to employ a battery (=1,200 Daniells) to overcome the resistance of the voltameter. After the current had passed for two days the electrolyte had a brown color and a slightly acid reaction. The battery was then reduced to 100 Bunsen elements, and after ten days 20 Bunsens were sufficient, which acted for thirty days. The water became black, the electrode, which weighed about 500 grms., was totally disaggregated, and at the bottom of the voltameter there was a thick muddy deposit. On analyzing the electrolyte there was found mellitic acid and some of its derivatives, such as hydro-mellitic, pyromellitic, and hydro-pyromellitic acid. In the muddy deposit there was found a black matter, soluble in hot water and alkalies, but insoluble in most mineral acids and the majority of organic solvents. They name this substance mellogen, since on oxidation it produces the acids of the benzo-carbonic series. Its analysis leads to the formula $C_{11}H_3O_4$.—*A. Bartoli and G. Papasogli.*

## BREAD ANALYSIS IN MASSACHUSETTS.

A RECENT report of the Massachusetts Board of Health gives the following interesting particulars as to the analysis of samples of bread bought in the State. One hundred and three samples of bread were tested for alum. Of these seven were known to contain it, and two known to be free from it. Of the remaining number, seven contained a very small quantity, less than one-tenth of one per cent., and eighty-eight were entirely free from it. These ninety-five samples were purchased from as many different bakehouses, without it being known to the baker for what purpose the bread was to be used. Twenty of these samples were also incinerated, and the ash examined for other mineral adulteration—but none was found. All the bread examined looked, smelled, and tasted well. The moisture was estimated in thirteen samples, and varied from 31·42 per cent. to 65·27 per cent. Only four of these contained over 38 per cent. The fat was estimated in house-made and in baker's bread. The two samples of home-made bread gave 1·12 per cent. and 1·17 per cent.; four of baker's gave 1·33 per cent., 1·34 per cent., 1·10 per cent., and 2·10 per cent. respectively. This would show that there is no important difference in the amount of moisture and fat in baker's bread and that ordinarily made in families. The "logwood solution" was used in testing for alum. This, though criticised, never failed to show alum when it was known to be present; and it is so delicate that it will show the presence of less than one part in ten thousand of crystallized alum in bread, and will do this even after the bread has been baked a month, and has been covered with mould. This was proved by the following experiment: samples of pure flour that had been tested were mixed with known amounts of alum, and baked in the ordinary way, taking care that no alum was introduced. The test worked very satisfactorily, both upon the samples of flour thus prepared and the bread which had been made from them.—*Sanitary Record.*

## EMULSIONS.

By Prof. C. LEWIS DIEHL.

AMONG the many preparations that manufacturers of pharmaceutic specialties have made much capital out of in recent years, emulsions of cod-liver oil take a very prominent place. From the claims set forth in their advertisements—which may be either by label, by circular, or by the personal interview of the manufacturer's agent—one is easily led to believe that not alone superior knowledge and skill are requisite in their production, but also that their successful production is possible only with the aid of expensive machinery and the advantages that are derived from abundant capital and a particularly favored market. Yet nothing is further from the truth; for while it is not disputed that a certain amount of knowledge and skill are required, that machinery is a necessity to the production of emulsions in large quantities, and that capital and a good market are advantageous in a commercial sense, their production requires no more knowledge and not as much skill as does the compounding of most of the prescriptions daily put up in our pharmacies, while all the apparatus necessary are a mortar and a pestle and accurate implements of measurement. These, with good, fresh cod-liver oil—which can be obtained without difficulty—make the production of an emulsion as easy an operation as the compounding of the simplest prescription. Moreover, such emulsions possess real advantages over the manufactured article. They are, in the first place, perfect emulsions, which the commercial products in many cases are not. Then, being prepared at the time when they are prescribed, they are absolutely fresh; and there is perhaps no class of preparations in which this is more desirable. It is true that the manufacturers usually claim that their emulsions keep well; but at the same time they are very careful to recommend that such be kept in a cool place. The truth is that, notwithstanding such care, the preparations furnished soon undergo change, become unsightly and unfit for use; and if it is further considered that this care in their preservation cannot always be observed, and, as a rule, is disregarded both by the wholesaler and retailer, it cannot be wondered that manufactured emulsions are often dispensed in a very unsatisfactory condition.

These considerations have suggested to me the propriety of offering some formulas for emulsions, in the hope that in the absence of authoritative formulas, physicians may find them of sufficient merit to adopt them in their practice; giving them at the same time the assurance that careful pharmacists following them will succeed as well as I have succeeded in preparing them.

The successful formation of emulsions, whether of fixed or volatile oils, is dependent upon certain rules, well understood by accomplished pharmacists, which, when deviated from, will invariably embarrass the operator, either by retarding or completely preventing perfect emulsification. These rules are :

1. That the water and gum arabic* shall be in definite and absolute proportion to each other. This proportion is 3 parts of water to 2 parts of gum, both by weight.

2. That the relation of oil to gum (and water) shall be definite within certain limits; that is to say, the mucilage formed in the above proportions is capable of perfectly emulsifying a minimum and a maximum proportion of oil. The minimum proportion is 2 parts of oil to 1 part of gum; the maximum proportion is 4 parts of oil to 1 part of gum.

3. That the trituration of the oil, gum, and water be continued until a perfectly homogeneous, milky-white, thick creamy mixture is formed—*i. e.*, until perfect emulsification takes place—before the addition of a further quantity of water or other liquid.

The thick creamy emulsion obtained, if the above conditions are fulfilled, must be the basis of all perfect emulsions. It will bear dilution to any extent with water, forming mixtures varying, according to the proportion added, from the appearance and consistence of cream to that of very thin milk. Obviously the water may be substituted by solutions of saline compounds,* sirups, etc., and this enables the production of the various combinations of cod-liver oil in current use from the above thick-creamy emulsion, which for distinction I shall designate as—

I. *Concentrated Emulsion of Cod-liver Oil.*—Take of fresh Norwegian cod-liver oil, 8 troy ounces; powdered gum arabic, 2 troy ounces; distilled water, 3 troy ounces. First weigh the gum into a wedgwood or porcelain mortar, then the oil, and triturate till the gum is well mixed with the oil; then weigh into the mixture the distilled water, and triturate the whole briskly until the mixture thickens and acquires a pasty consistence and milky whiteness. Now scrape down the portions adhering to the sides of the mortar and to the pestle, and continue the trituration for a short time, after which add such other ingredients as may be desirable, or transfer the concentrated emulsion to a wide-mouthed bottle for future use.

This concentrated emulsion will keep for a reasonable time in cold weather, and, if placed in the ice-chest, also during warm weather. It may, therefore, be kept in stock if the demand for emulsions is brisk enough to justify it; but inasmuch as its preparation does not consume more than five or ten minutes, it is advised to always prepare it fresh, or, at all events, never to prepare more than a week's supply, particularly in summer. Its consistence is such that it is poured out of the containing vessel with difficulty; hence the necessity of using one with a wide mouth, which should be as securely stoppered as possible, and should be cleaned very carefully each time it is refilled. All this takes time and involves trouble, which is prevented by preparing the concentrated emulsion only as required.

II. *Simple Emulsion of Cod-liver Oil.*—Take of concentrated emulsion of cod-liver oil, 13 troy ounces; oil of wintergreen, 24 drops; sirup, 1 fluid ounce; water, 3 fluid ounces.* Weigh the concentrated emulsion into a mortar, add the oil of wintergreen, and triturate thoroughly, then gradually add first the water and then the sirup.

The manipulation for this emulsion is typical for all the other cod-liver oil emulsions given below. It has the consistence of very thick cream, but is readily poured out of narrow-mouthed bottles, is milky white, and mixes readily with water or other liquids that may be administered with it. It contains exactly 50 per cent. (by volume) of oil, the quantity that manufactured emulsions are said to contain, although I have convinced myself that some of them do not contain that proportion. The oil of wintergreen disguises the odor of the cod-liver oil very admirably, and has the further advantage that it acts as a preservative.

III. *Emulsion of Cod-liver Oil with Hypophosphite of Lime.*—This differs from the simple emulsion in that 128 grains of hypophosphite of calcium are dissolved in the water, each tablespoonful of the finished emulsion containing 4 grains of that salt.

IV. *Emulsion of Cod-liver Oil with Hypophosphites of Lime and Soda.*—This differs from the simple emulsion in that 128 grains of hypophosphite of calcium and 96 grains of hypophosphite of sodium are dissolved in the water, each tablespoonful of the finished emulsion containing 4 grains of the calcium and 3 grains of the sodium salt.

V. *Emulsion of Cod-liver Oil with Hypophosphites.*—This differs from the simple emulsion in that 128 grains of hypophosphite of calcium, 96 grains of hypophosphite of sodium, and 64 grains of hypophosphite of potassium are dissolved in the water; each tablespoonful containing 4 grains of the calcium, 3 grains of the sodium, and 2 grains of the potassium salt, and corresponding to a teaspoonful of Churchill's sirup of the hypophosphites.

VI. *Emulsion of Cod-liver Oil with Phosphate of Lime.*—This differs from the simple emulsion in that 256 grains of phosphate of calcium are dissolved in the water by the aid of 128 grains of hydrochloric acid;* each tablespoonful containing 8 grains of the phosphate held in a pleasantly acid solution.

VII. *Emulsion of Cod-liver Oil with Phosphate of Lime and Soda.*—This differs from the simple emulsion in that 256 grains of phosphate of calcium and 64 grains of phosphate of sodium are dissolved in the water acidulated with 128 grains of hydrochloric acid, each tablespoonful containing 8 grains of the calcium and 2 grains of the sodium salt.

VIII. *Emulsion of Cod-liver Oil with Lactophosphate of Lime.*—This differs from the simple emulsion in that 256 grains of lactate of calcium dissolved in two fluid ounces of diluted phosphoric acid are substituted for 2 fluid ounces of the water, each tablespoonful containing 8 grains of lactate of lime or about 10 grains of lactophosphate.

IX. *Emulsion of Cod-liver Oil with Wild-cherry Bark.*—This differs from the simple emulsion in that the oil of wintergreen is substituted by 8 drops of oil of bitter almonds, and in that 1 fluid ounce of the fluid extract of wild-cherry bark is substituted for 1 fluid ounce of the water, each tablespoonful containing 15 minims of the fluid extract and one-fourth of a drop of oil of bitter almonds.

Other combinations of cod-liver oil with different medicinal agents may be effected in the same way as pointed out in the above, or the proportions of salts may be varied to suit particular cases. The process for the concentrated emulsion also may be applied to the emulsification of other oils, as, for instance, in the following:

X. *Emulsion of Castor-Oil.*—Take of castor-oil, 4 troy ounces; powdered gum arabic, 1 troy ounce; distilled water, 1¼ troy ounces; sirup, cinnamon water, of each 3 fluid ounces; spirit of cinnamon, 12 minims. Emulsify the oil with the gum and distilled water as directed under I., then add the other ingredients successively with constant trituration. The emulsion contains 33 per cent. of castor-oil, and is consequently more limpid than the 50 per cent. cod-liver oil emulsions above described, and is in every respect an elegant preparation.—*Louisville Med. News.*

* The writer is well aware that other emulsifying agents have been proposed and are used, but he is satisfied that none of these answer as well as does gum arabic.

* The use of hydrochloric acid instead of phosphoric acid is preferred, because the large quantity of the latter required would make the preparation unpleasantly sour.

## EFFECTS PRODUCED IN A VACUUM BY THE CURRENT OF GRAMME MACHINES.

By MM. JAMIN and G. MANEUVRIER.

THE effects are those of batteries with an intensification due to the enormous tension, and those of the coil with the intensification which results from a greater quantity of electricity. When the vacuum reached about 12 mm., the light began to spring out not in the form of a luminous arc confined between the points, but from all parts of the carbons with the ordinary aspect of the effluve in a Geissler tube; each of them showed at once the appearances which characterize the two poles with the coil. The carbons are heated to whiteness in their entire length, and become volatilized. The receiver is filled with a blue gas, which gradually deepens almost to the color of indigo. The vapors then condense on the sides of the receiver, rendering them opaque, and terminating the experiment. The deposit collected resembles very finely-divided carbon, and dissolves in nitric acid with effervescence and incandescence. The nature of this carbonaceous matter is under examination.

MAGNETIC VARIATIONS OF MAGNETIZED RODS DURING STORMS.—Lightning, even at a distance, has a real action upon the magnetism of magnetic rods, though the influence under ordinary circumstances is neither strong nor rapid enough to be indicated by the needle of the compass.—*G. de Lalagade.*

[NEW YORK MEDICAL JOURNAL]

# THE BIRTH OF AN ELEPHANT.*

By GUSTAVUS E. SUSSDORFF, M.D.

AN event so novel as the birth of an elephant in this country naturally attracts considerable notice, and excites great interest in the minds of scientists, as well as of the people generally. The opportunities for observing the animal in labor have been very limited, but few elephants having been born in a state of captivity; in fact, I believe almost the only cases of the kind so far known have occurred in the United States, the first one having been born in Philadelphia, out of Hebe, in 1880, and the second in Bridgeport, Connecticut, in 1882, out of Queen.

The following is the history of the elephant Queen's case: On June 15, 1880, she successfully paired with the male elephant Chief at Lowell, Massachusetts. Several attempts had been made on June 11, at Boston, and one afterwards at Dover, New Hampshire, but were unsuccessful. Computing the time, therefore, from June 15, 1880, to February 3, 1882, the date of delivery, we find the period of gestation to have been 597 days—a difference of 4 days from Owen's case.

In this case there was no noticeable enlargement of the abdomen until it suddenly became quite prominent the day before labor began. This enlargement did not subside with the expulsion of the fœtus and after-birth, but continued four days longer. During the latter months the mammæ became swollen, and soon filled with serous milk. These were the only signs of pregnancy to be seen.

The labor began at 3 P.M., February 2. At this time the mammæ were greatly distended with milk, which came away continuously in drops. The vagina now began to drop down and swell. In a short time thick mucus began to come from the vagina in long ropy strings, and almost poured out just before delivery. (This statement that it was mucus is doubtless correct, as the sequel will show.) From 3 until 8 o'clock Queen was evidently uneasy, as she constantly moved her body from side to side, but did not seem to suffer *pain*, and quietly munched some hay up to the very moment of delivery. At 8:10 the young elephant was born, the head presenting, completely enveloped by the unbroken membranes. The head and part of the body rested between the hind legs of the mother, and touched the ground (see Fig. 1). Without waiting a moment, the mother ruptured the membranes with her two hind feet, when the young one rolled out, on its back. The membranes were no sooner liberated than they quickly returned into the vagina. The umbilical cord had not been seen at all, having probably been torn away during the descent of the fœtus.

The mother now quickly turned to the young, and, on seeing it, began to roar and bellow furiously, which she continued for ten minutes. As soon as she saw the baby she also at once placed one fore foot on it and rolled it several times, as one does a lemon under the palm of the hand, the bellowing and roaring continuing.

In a moment or two more she placed her abdomen upon a short post in the ground, to which she was chained, standing almost upon her head, and grasping the post with her trunk, thus forcing the abdomen with great power against the post. Fig. 2 shows the position assumed far better than words can do. Queen remained in that position for about ten minutes, then became quiet, and, while playing with her young, took some food.

Nothing indicative of after-pains could be recognized after this, and in one hour and thirty minutes the placenta was expelled. With it there came about two quarts of clotted blood. There was no hemorrhage either from the uterus or from the umbilicus of the calf.

The duration of labor was five hours and ten minutes. The calf, a female, weighed 245 pounds, and stood just 3 feet high. It began nursing one hour and forty minutes after birth. It had two middle upper teeth.

FIG. 1.—BIRTH OF AN ELEPHANT.

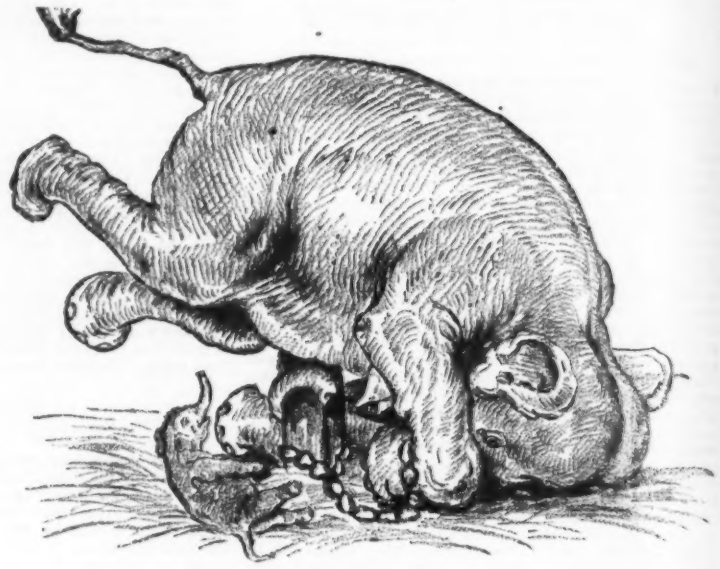


FIG. 2.

I am sorry I was unable to be present at the accouchement of the elephant Queen last February, but I have fortunately come into possession of some interesting facts concerning that event through my friend, Mr. H. H. Cross, who was present and assisted in the delivery, and who has had much experience with these animals, both wild and in a state of captivity. The same gentleman secured the placenta and fœtal membranes at the time, which he has kindly loaned to me. He has also made several drawings of the elephant during and after labor.

I come before you, therefore, for the purpose of relating these facts, and to offer for your inspection what remains of the fully developed placenta and fœtal membranes. I am sorry to say the specimen is not perfect, as part of it was much mutilated at delivery.

Respecting the period of gestation in the elephant, Owen, in his "Comparative Anatomy and Physiology of Vertebrates," says: "A male and female Indian elephant paired December 18, 1863, and at other times up to January 8, 1864, when they were kept apart. For twelve months there was no conspicuous increase of the abdomen, but after that period it was obvious to close inspection on the left side; then the mammary glands enlarged, with slight occasional oozing of milk, and on August 3, 1865, the young was born. It stood 2 feet 10 inches high, and weighed 175 pounds. The period of gestation, reckoned from the date of the first coitus, was, therefore, 593 days."

The umbilical cord entered the abdomen about three inches anterior to the vagina, and had been detached very close to the abdomen, as none was visible at that point, the canal being open and large enough to admit a good-sized finger for half an inch.

There are several very interesting and instructive points in this history. First, the period of gestation is evidently not affected by change of climate and captivity, lasting about nineteen and a-half months. The time of labor is short, and evidently there is not much pain. The sagacity of the animal is remarkable, as shown by the manner in which she ruptured the membranes, the means she took to excite respiration by rolling the young, and, finally, her effort to express the placenta from the uterus.

Leaving this part of the subject, I will endeavor to describe the placenta and fœtal membranes. In doing so I shall follow, to a great extent, the description of Owen, who was enabled to study this organ in a perfect condition, though at the middle period of gestation, whereby I may perhaps be able to point out the relation of that part which has been destroyed in this specimen to the other parts remaining uninjured.

The chorion of the elephant forms a transversely oblique sac, and in the specimen we have here, must have measured in its long diameter, before the membranes were so much torn, at least five feet, as the remaining half, which is perfect, measures 31 inches, and the short diameter measures about 3 feet 4 inches. At the center the chorion is surrounded by the placenta, which, instead of being a continuous band, as it has been described, is in this instance composed of five parts, each more or less separated from

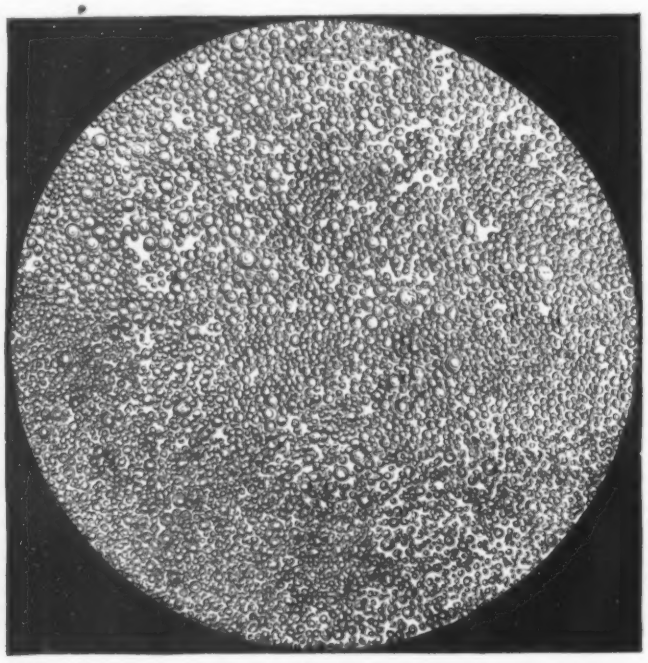


FIG. 3.—COW'S MILK.†

From a photomicrograph by M. Manly Miles, Director of the Experiment Department of the Houghton Farm, Mountainville, Orange County, N. Y.

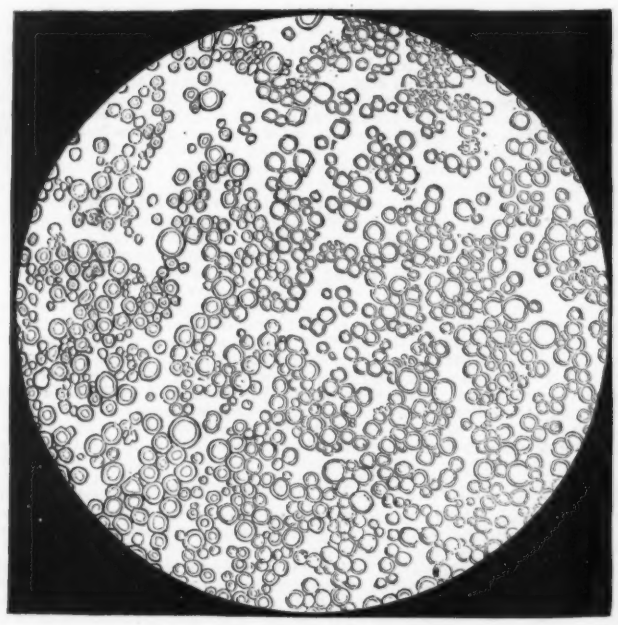


FIG. 4.—ELEPHANT'S MILK.

From a photomicrograph by Mr. Miles. The amplification is the same as in Fig. 3.

* Read before the New York Medical and Surgical Society, May 27, 1882.

† For the photomicrographs from which this and the following drawings were copied we are indebted to the kindness of Mr. P. T. Barnum.—EDITOR.

the other, some at a distance of half an inch, and others an inch or more. The middle one is placed opposite to the point where the umbilical vessels are attached. Here, as I will show you, there is a considerable space on each side, having no connection with the others, except by the placental blood-vessels and membranes.

The circumference of the placenta around the rough portion is about 4 feet 3½ inches, and in breadth it is fully 6 or 7 inches, while in thickness it is 2½ to 3 inches. "It presents the same spongy texture as does the annular placenta of the carnivora, but the laminate villosities inclosing the fœtal filaments enter into its formation in a larger proportion, and are of a relatively coarser character" (Owen). In the specimen Owen describes, the greater portion of the convex surface of the placenta was smooth, the rough part, separated from the serotine portion, occupying a narrow tract. In this specimen, however, we see that the rough part composes the entire surface.

"The outer surface of the chorion for the most part is smooth, but at each of the obtuse extremities of the sac there is a villous and vascular subcircular patch, the villi being short and graniform, one-sixth of a line or less." We find the patches well shown in this specimen, though the villi are longer.

The chorion is connected with the uterus principally by the annular or zonary placenta, and also at each pole of the sac by means of the subcircular patch just mentioned. The umbilical cord, when inclosed as it was by the delicate neck of the allantois, the connecting cellular tissue, and the covering of the amnion, probably measured in this specimen about 15 inches, but as we find it, with envelopes torn off, it measures, from the fœtal end to the entrance of the blood-vessels into the placenta, 32 inches. The cord is formed by one venous and two arterial trunks, covered by the membranes, as just stated, and is more or less flattened. In circumference it measures four inches.

The amnion on its internal surface is covered by dark, rough granules placed hemispherically, varying in size from one half to two lines; its external surface is corrugated, but not rough. A bag can always be found in the natural state, formed by the non-vascular layer of the allantois, of considerable size, which is continued from the base of the cord, and is so arranged between the chorion and amnion as to prevent any part of the amnion from attaining the inner surface of the placenta.

The analyses of the samples gave the following results:

| | I. April 5. MORNING. | II. April 9. NOON. | III. April 10. MORNING. |
|---|---|---|---|
| Quantity | 19 c. c. | 36 c. c. | 72 c. c. |
| Cream | 52·4 vol. p. ct. | 58 | 62 |
| Reaction | Neutral. | Slightly alkaline. | Slightly acid. |
| Sp. gr. | .. | ... .. | 1,023·7 |
| In 100 parts by weight: | | | |
| Water | 67·567 | 69·286 | 66·697 |
| Solids | 32·433 | 30·714 | 33·303 |
| Fat | 17·546 | 19·095 | 22 070 |
| Solids not fat | 14·887 | 11·619 | 11·233 |
| Casein | 14·236 | 3·694 | 3·212 |
| Sugar | | 7·267 | 7·392 |
| Ash | 0·651 | 0·658 | 0·629 |

Now, what possibly can be of greater moment than to learn how much motion is required to evolve 1° of heat? We know how great a weight, and how much space; but now comes the question, how rapid must be the motion? The velocity acquired by a falling body at any instant of its fall is equal to the square root of the product of twice the force of gravity and the space fallen through. If a body be let fall, it will be found by delicate instruments to be moving, at the close of 1 second, with a velocity of 32·2078 feet per second. And this velocity is an expression for the force of gravity exerted by the mass of the earth on bodies near its surface. By the rule 32·2078 multiplied by 2 equals 64·4156, and this multiplied by 772, equals 49,729 feet, whose square root is 223. Of all numbers known to man for purposes of physical research, this 223 is the most important; for we now know that 1 pound of matter moving with velocity of 223 feet per second generates heat enough, when

COMPARATIVE ANALYSES OF MILK IN MAN AND ANIMALS.

| | Women. | Cows. | Goats. | Ewes. | Asses. | Mares. | Buffalo Cows. | Camels. | Sows. | Hippopotami. | Elephants |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 86 271 | 84·28 | 86·85 | 83·30 | 89·01 | 90·45 | 80·640 | 86·34 | 81·80 | 90·43 | 66·697 |
| Solids | 13·729 | 15·72 | 13·52 | 16 60 | 10·99 | 9·55 | 19·360 | 13 66 | 18·20 | 9·57 | 33·303 |
| Fat | 5·370 | 6 47 | 4·34 | 6·05 | 1·85 | 1·31 | 8·450 | 2·90 | 6·00 | 4 51 | 22 070 |
| Casein | 2·950 | 3·57 | 2 53 | 5·73 | 3 57 | 2 53 | 4·247 | 3·67 | 5·30 | 4·40 | 3·212 |
| Albumen | .... | 0·78 | 1 26 | .... | .... | .... | .... | .... | .... | Milk sugar included. | ..... |
| Milk-sugar | 5·136 | 4·34 | 3 78 | 3·96 | 5·05 | 5·42 | 4·518 | 5·78 | 6·07 | .. .. .. | 7·392 |
| Ash | 0·223 | 0·63 | 0 65 | 0·68 | ... | 0·29 | 0·845 | 0·66 | 0 83 | 0·11 | 0·629 |
| Nitrogenized | 2·950 | 4·35 | 3 79 | 5·73 | 3 57 | 2·53 | 4·247 | 3 67 | 5.30 | .... ... | 3·212 |
| Non-nitrogenized | 10·506 | 10·81 | 8·12 | 10·01 | 6·90 | 6·73 | 12·968 | 8·68 | 12·07 | . .. ... | 29·462 |

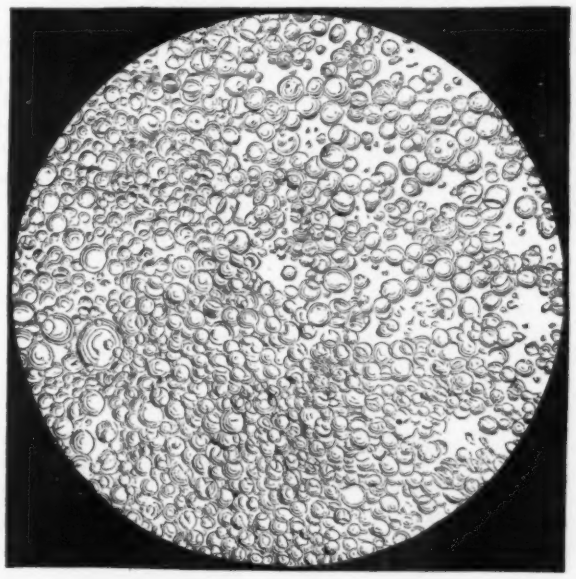


FIG. 5.—ELEPHANT'S MILK.

From a photomicrograph by Edwin W. Martin, Assistant Sanitary Inspector of Milk, Health Department, City of New York.

The allantois divides into three sacculi. One extends over the inner surface of the annular placenta and for a short distance into one end of the chorion; a second extends into the opposite end of the chorion; while the third subdivides into two smaller cavities, each ending in a cul-de-sac. Unfortunately, the tissues are so much mutilated that it is impossible to demonstrate this arrangement of the allantois. "The branches of the umbilical arteries and vein diverge from the umbilical cord in four divisions; they reach, first, the borders of the placenta, and then ramify in its substance and upon the inner surface of the chorion." This arrangement of blood-vessels is easily seen in the specimen. "Upon the endo-chorionotic vessels are developed a number of flattened, oval, or subcircular bodies, of a compact structureless tissue" (varying in diameter in this instance from an inch or two to a few lines). They are very numerous near the placenta, and become scattered as they near the poles of the chorion. Owen counted 120 of these bodies, and in this specimen I have counted 208.

Since writing the foregoing, I have read Dr. Henry C. Chapman's monograph upon "The Placenta and Generative Apparatus of the Elephant," in the "Proceedings of the Academy of Natural Sciences of Philadelphia," second series, vol. viii., which contains a number of illustrations of the placenta, membranes, and generative apparatus. In the illustration therein given the placenta is shown to be continuous, while the one shown by me, as stated already, is divided into five parts.

Professor Chapman fixes the period of gestation at from 630 to 656 days, a considerable difference from Professor Owen's case and that of the one herein given.

The photomicrographs given herewith are interesting in so far as they are the first of the kind of elephant's milk, and a valuable contribution to the comparative composition of milk in general.

Dr. Charles A. Doremus, of New York, has analyzed the milk of the elephant Hebe from specimens taken April 5, 9, and 10, 1880, which I append hereto, together with his table showing the comparative composition of milk in man and animals.

## FACTS AND FANCY CONCERNING COMETS.

By PROF. E. L. LARKIN.

AT intervals of considerable regularity the press is burdened with accounts of impending disaster. Some dire astronomical event is always about to occur that will annihilate the human species. A Chicago writer, oblivious of the laws of gravity and motion, predicted evil to the earth to fall on June 19, 1881, and published a diagram of the solar system as it would appear on the eventful day. The earth was to suffer because it would be on one side of the sun, while the large planets on the opposite would so attract our world as to attract earthquakes, pestilence, and death. So dense was the ignorance of the alarmist, that he actually diagramed Venus on the wrong side of a sun, in a position in which it would not arrive for more than six months. June 19 came, and was all serene, but we read of some being rendered insane by these publications. And now it is sought again to awaken fear by the formulation of predictions of appalling heat that is to reach the earth, because the great comet that illuminated the circumpolar heavens last summer passed perihelion at a point close to the sun. The scheme to destroy mankind is that the comet, on its return in 1897, will suffer sufficient retardation in passing through the gases constituting the corona of the sun to cause it to fall. Inconceivable heat will be generated from the arrested motion, and waves of it will surge against the earth, literally burning humanity alive. All such doctrines are without the slightest grounds in reason or scientific deduction, and the mystery is why any man pretending to astronomical or mathematical acquirements will print such dogmas.

If we raise a mass weighing 772 pounds one foot, and then let it fall, the precise amount of power required to raise it will be restored, and will appear in the form of heat, at the instant of impact of the mass on the earth. And, as has been proven, the amount of heat generated is just enough to raise the temperature of 1 pound of water 1° F. But the heat evolved by the fall of 772 pounds 1 foot is equal to that developed by the fall of 1 pound 772 feet. A mass weighing 1 pound that has fallen 772 feet has motion sufficient to conserve heat enough to heat 1 pound of water 1°; or 1 pound of water falling 772 feet generates 1° of heat throughout its mass. This is termed Joule's heat equivalent, and is a valuable element of human knowledge. It is a postulate of recent science that when one mode of force vanishes, another of equal intensity takes its place. Force cannot be increased or diminished; it is one of nature's constants. Motion is a mode of energy, and, invariably, when it terminates, heat—another form of force—appears.

its motion ends, to heat 1 pound, of water 1°. That is, this velocity represents 1 pound-degree of heat, or simply 1°, water being unity. With this magic number, all depths of space may be explored, and it can at once be told how much heat will be evolved by the cessation of motion of any cosmical body, as soon as it is learned how fast it is moving.

Having now the heat unit of the universe refined down to definite velocity, we are ready to launch into interstellar space, to learn first the velocities of bodies moving therein, and, secondly, to calculate the intensity of heat capable of being developed if the motion should be brought to a rest. The rule for finding the amount of heat evolved by the termination of the motion is: Multiply the square of the velocity in feet per second by the reciprocal of the square of 223, or 0·00002010899.

If a mass of matter fall from an indefinite distance, with unimpeded motion, and strike the earth, its velocity at the instant of impact is equal to the square root of the product of twice the intensity of gravity multiplied by the length of the radius of the earth. And this motion at the moment of collision must be found in feet per second, because the unit of measurement is 223 feet per second. Twice the force of gravity is 64·4156, and the mean equatorial radius of the earth is 20,923,161 feet. The square root of the product of these numbers is 36,645 feet, or 6·94034 miles per second, velocity acquired by a mass falling on the earth from a distance that is infinite. The force of gravity on the surface of the sun is 27·696 times stronger than on the earth's surface, while the radius of the sun is 108·5113 times greater than that of the earth. Therefore, by the law of gravity, the velocity of impact of cosmic matter on the sun must be 54·8208 times more rapid than on the earth. This is known, because the square root of the product of 27·696 and 108·5113 is 54·8208, whence 36,645 multiplied by 54·8208 gives 2,008,908 feet, or 380·0962 miles, per second velocity with which a mass would strike the sun after falling from an infinite distance. And this inconceivable motion must all be converted into heat at the instant of collision. Now, square 2,008,908, multiply the product by 0·00002010899, and we have the appalling heat of 81,154,081° F. as the intensity generated by cometary or other cosmic bombardment of the sun by masses that fall from infinite distances. Some sensational writers, having heard of this, at once seek to alarm all timid people by printing outrageous accounts of the impending destruction of man. Such publications are little better than criminal.

What we have said relates to bodies making impact on the sun after reaching it from distances that are infinite; now, how great velocity will be imparted to masses falling from distances that are finite, and capable of being handled by figures? Distance in relation to solar gravity has peculiar properties, thus: the nearest sun to ours is 20,000,000,000,000 miles away; let us go out into space half way, or 10,000,000,000,000 miles, and make computation, seeking to learn with what velocity a mass beginning to fall from that point will finally strike the sun. The velocity, 2,008,908 feet per second, is called the solar constant of velocity, and many complicated problems wherein gravity and motion are factors can be solved in a few minutes by its use. Employing it in a calculation for a radius 10,000,000,000,000 miles, and carrying out the work into minute decimals, we shall be surprised to find that the velocity of impact on the sun, by a mass falling that distance, is only one-fourth of an inch less per second than if it came from an infinite distance, or, what is the same thing, had been falling for ever! Surprise will wane, however, when it is remembered that gravity varies as distance squared inversely, and at an infinite distance must be infinitely weak, and the motion it can impart infinitely slow. Hence, 10,000,000,000,000 miles has nearly the same relations to solar gravity that infinite space has. Drawing nearer the sun, let us halt at the orbit of Neptune, 2,780,000,000 miles distant, and again apply the formula; when behold, if a mass fall through the distance of Neptune, it will reach the sun with only 155 feet per second less velocity than if it had been falling throughout all duration of time. Still nearer, we come to the orbit of the earth, 92,000,000 miles from the sun's center, and, again computing, find that final velocity of impact on the solar globe of matter from terrestrial distance, would be but 2,411 feet per second less than if it had arrived from infinite space. By the use of this important number, 2,008,908, it can at once be told what is the velocity of any cosmical mass at any point in its flight to the sun. Calculating for the earth's distance, it is found that a body passing our world on its way to the sun has a velocity of 26 miles per second, which is the greatest velocity with which anything can strike the earth. Arriving at the orbit of Mercury and again calculating, we find that a mass beginning to fall from that distance, 36,090,000 miles, will impinge on the sun with a rate of motion only 5,706 feet per second less than if it had been falling for ever. Hence, terminal velocities lie within small limits of variation.

Here is a table of velocities in feet per second of bodies making impact on the sun, falling different distances:

| | |
|---|---|
| From infinite distance, maximum | 2,008,908 |
| From Neptune | 2,008,753 |
| From Mars | 2,007,361 |
| From the earth | 2,006,497 |
| From Mercury | 2,003,202 |
| From 436,000 miles, minimum | 1,420,513 |

It is seen that interstellar matter, whether colliding with the sun from infinite fall, or from Mercury, has 5,706 feet, a trifle over 1 mile per second difference in final velocity, variation being within the limits of 1-380 of the whole. The rate of the motion in the last line of the table is that attained by a mass falling on the sun from a distance equal to the solar radius, 430,000 miles, as we can not imagine that any cosmic matter will begin to fall from a less distance. Therefore the least velocity of impact is 1,420,513 feet, or 269 miles, per second, and this least motion multiplied by 1·414213 equals 2,008,908, the greatest, hence the maximum and minimum velocities are to each other as 1 is to the square root of 2, or as 1 is to 1·414213.

If we square 1,420,513 and multiply the reciprocal of the square of Joule's equivalent, as above, we obtain the least heat possible, or 40,577,090° F. What astonishing results are brought to light by these researches. Incredible intensity of heat, the highest being 80,000,000° and the least 40,000,000°! What effect will such outbursts of thermal energy have on the earth? Will the heat vaporize the oceans, parch the land, and consume all organisms? Let us see. First, we must find the relations between velocity, heat, and mass. Take any mass at random, say 52 pounds, and give it any velocity, say 892 feet per second, how intense will be the heat evolved when its motion ends? By analysis, 1 pound moving 223 feet per second has a motion sufficient to generate heat enough to increase the temperature of 1 pound of matter of the density of water 1°, hence if it moves 4 times as fast, or 892 feet, it has a motion able to develop heat 16 times more intense, or 16°, because the square of 4 is 16 times greater than the square of 1, the ratios of their velocities.

If a mass weighing 1 pound, moving 892 feet per second, generates on impact 16°, 52 pounds will evolve 52 times that amount, or 832°, but the heat will still have the same intensity. By thermometer the mass will indicate only 16°, that is, 52 pounds moving 892 feet per second, can generate heat enough to heat 1 pound of water 832°, 832 pounds 1°, or 52 pounds 16°. Now double the mass by making it 104 pounds, the velocity remaining the same, and we double the quantity of heat and will have 1,664°; still the thermometer reads 16°. The 1,664° being distributed through twice the mass, can have no greater intensity than that conserved from its velocity. Therefore:

1. Increase of mass does not increase the intensity of heat. If we double velocity instead of mass the heat is quadrupled in intensity, thus: 892 multiplied by 2 equals 1,784, and the square of 2 is four times greater than the square of 1; and since heat of impact is proportional in intensity to squares of velocities, we have four times the heat energy, or 3,328° in amount, and four times the intensity, or 64°. This is because four times the heat raises the temperature of 52 pounds four times 16°, or 64°, the 3,328° degrees being able to warm 3,328 pounds 1°, 1 pound 3,328°, or 52 pounds 64°. Whence:

2. Heat depends for intensity on velocity, and not on mass. Let 1 pound of matter strike the sun, and whether it fall from an infinite distance or from the distance of any planet its motion will develop on collision, in round numbers, 80,000,000°; let a mass of 2 pounds impinge, and double the amount of heat will appear, but its intensity will be the same, since the final velocity cannot be more than 380·0962, nor less than 379·3943 miles per second. Thence:

3. A comet of great mass colliding with the sun will produce no greater intensity of heat on the sun or earth than one of small mass. Velocities of impact mentioned are those of interstellar masses falling on the sun with unimpeded motion on straight lines. Any comet that can make impact must move around the sun many times before it can collide, its perihelion at each circuit approaching, until finally it is so far retarded by gases in the vicinity of the sun that its orbit comes to almost coincide with the solar surface. Then, if the nucleus is solid, it will ricochet like a canon ball, and surrender portions of its heat at each impact, nothing like 80,000,000 degrees being developed at any point. When:

4. Maximum heat can not appear unless cosmic matter fall on right lines to the sun, and not on curves. Heat is now known to be a mode of atomic motion; the greater the rapidity of atomic oscillation the more intense the heat. The reason why a mass on collision evolves heat is because the motion of the whole mass through space is instantly arrested, and massive motion becomes atomic. When the body is moving, each atom in it maintains constant relation to all the others, and no heat is developed. Let the mass strike a solid and each atom begins motion in relation with every other, the instant translation through space ends. If the velocity of impact is great, atomic motion is most rapid, and the heat intense. If the collision is not powerful enough to cause every atom to shift position, all the heat possible will not appear. Let a rifle ball strike a rock, every atom of the lead changes location, the ball is flattened, and, if velocity is sufficient, melted. But if it strikes a mass of cork, resistance being so slight, the lead atoms will not shift nor heat appear. Behold the sun; its density is only 1·44, that of water being one, or about the consistency of calcimine applied to our ceilings. A comet would plunge thousands of miles beneath the liquid surface of the sun, and the heat would slowly radiate away, benefiting man instead of destroying him. Therefore,

5. Eighty million degrees of heat cannot develop unless the sun becomes rigid as platinum and cometary nuclei solid But it is not on these arguments that we rely. We will grant that comets can fall upon the sun, developing maximum heat, allowing alarmists the worst, and then demonstrate that such impact can not affect the earth in any way except for good. If we burn fifty pounds of coal in one hour it will radiate genial heat, and an iron bar suspended, say at a distance of four feet from the fire, will be warmed through, supposing it to be an inch in thickness. Now, put on a blast and consume the coal in one minute; the bar will not be warmed throughout. Consume the coal in one second, and the surface only of the bar next the fire will be warmed. Burn the coal in the millionth part of a second, the same amount of heat will be given out as when one hour was occupied in the combustion, but the human hand could be held in place of the bar and not feel pain. The heat would be intense, but of such inconceivably short duration that it would not destroy the structure of one's hand. Whence time is a factor in all problems where the action of heat is concerned. Now, let a mass in motion at the rate of one foot per second collide with the sun, and we say the time consumed in impact is such a part of a second: but let it move 2,008,908 feet per second, the time of collision is 2,008,908 times shorter, and the heat that many times more intense, the intensity of the heat depending solely on the time of impact, and the time directly on velocity. Hence:

6. The intensity of 80,000,000 degrees exists less than the 1-2,008,908 part of a second, and the heat-wave that can strike the earth will have the same duration. Heat, light, or any other energy emanating from a center, varies in the inverse ratio of the square of the distance. The earth is 92,000,000 miles from the sun, but to arrive at results, a ratio must first be deducted. Suppose that above where the comet strikes we place a flat surface at a distance of 100,000 miles, and admit that the radiation of heat hereon from the disintegrated comet would be 80,000,000 degrees. Of course it would not be that intense, for of such intensity is the heat 100,000 miles below; but allow that it would be, then how intense will be the heat reaching the earth? The quotient of 92,000,000 divided by 100,000 is 920, and the square of this number is 846,400. Then the heat falling on the earth is 846,400 times less than that radiating on a surface 100,000 miles from the scene of collision. Dividing 80,000,000 degrees by 846,400, we find the intensity of a heat-wave that can reach the earth from the disruption of any comet, large or small, on the sun, to be 94 degrees. Take a hot day with the thermometer at 94 degrees, double the heat for the 1-2,008,903 part of a second, or indeed for half a minute, and observe the effect on the human species. Really the only way to detect the arrival of the wave would be to turn a large telescope on the sun just before the comet fell, and place in the focus one of Prof. Langley's balometers capable of measuring 1-50,000 degree of heat, and look intently on the index with the microscope. Even then it is doubtful if movement of the delicate balance could be seen. We should be pleased to have our telescope set upon the precise point of impact at the time the comet falls to see what would take place. It is scarcely possible that a movement so rapid would make impression on the retina. And high magnifying powers would have to be used, since one second of arc on the solar disk is in linear dimensions 450 miles, and is as small an object as can be seen in a telescope on the sun. But the comet of 1811 had for what was supposed to be a solid nucleus a diameter of 428 miles—less than one second of angular measurement when at the sun's distance; hence the final plunge of a comet into the solar flames could only be seen in good telescopes under favorable circumstances. But a tele-spectroscope of powerful dispersive powers set on the spot after impact might in the spectrum produced exhibit slight disturbance, such as displacement of the lines caused by outbursts of hydrogen and other gases. Hence:

7. The effect of cometary precipitation on the sun can not be detected on earth save by the most powerful instruments. What is the sun? It is a colossial ball 86,000 miles in diameter, whose mighty mass is 331,654 times greater than that of the earth. What is a comet falling into this awful furnace? Nothing but as one firebrand in the conflagration of Chicago. Explosions are always taking place on the sun, causing greater upheaval than the downrush of a dozen comets. Can cometary collision on the sun injure man? Indeed, such impact serves to keep him alive. The sun does not radiate too much heat now, and astronomers are agreed that part of the present supply is kept up by cosmical bombardment. We are flung away in some nook of the universe chained to an expiring world—a home that is already suffering encroachment of polar ice. We exist only by the heat of the sun. The real danger lies not in cometary downrush, but in the fear that not enough meteors and comets will gravitate into solar fires. The longer comets continue to strike the sun, the longer can man inhabit the earth. We thought it the province of science to dispel superstition and fear; and least of all did we think that astronomy would be made use of as an engine of terror. We put in a plea for pure astronomy, and urge that its truths be not tampered with by sensationalists. Interstellar matter perpetually bombards the sun, each collision of meteoric hail sending to the earth life-sustaining heat. We trust this cosmic war will not cease, and that at least one comet per week will dash on the sun during the next ten thousand years.—*Kansas City Review.*

## NATURAL CHAMPAGNE.

*To the Editor of the Scientific American:*

The high and independent standing of your SCIENTIFIC AMERICAN encourages me to submit to you the opinion of Musprat's technical chemistry with reference to some points of champagne and sparkling wines, but preceding to it a few remarks on the subject appeared necessary.

The Clardy bill provides for a tax on imitation of still and sparkling wines. If the imposed tax makes the sparkling wines good for the consumer, it was also good without the tax, but if it is "adulteration," the manufacture of it should be prohibited. This bill was heartily indorsed by the "State Viticultural Society" of California, who stated to the San Francisco *Chronicle* that imitation champagnes (by impregnation of carbonic acid) are "heavy brown of color, unpalatable, and indigestible." The society supported its view by adducing eminent chemists, but they wisely omitted to name one of the eminent chemists. However, there are eminent chemists who express their opinion, but diametrically opposed to the view of the society, and perhaps just for this reason the leading daily papers of San Francisco objected to publication of not easily refuted statements. If the movement of the above society were really against "adulteration of wines and spirits," it were certainly a laudable proposition, but it is not there where the shoe pinches; it is not against adulteration but against the competition of the impregnated sparkling wines generally. The president of the State Viticultural Society is also the manufacturer of the so-called "natural champagne."

In Musprat's Technical Chemistry, German edition of 1880, page 124, it reads: "Those who with Puritan strictness insist that fermented grape wine should be pure, without artificial admixtures whatever, have to give up all sparkling wines and champagnes, because, although it is possible to produce a sparkling wine without an artificial admixture, it is never the case with that wine which is termed 'champagne.' All sparkling wines are ordinary good wines, which are converted into sparkling by the mode of making and by certain admixtures. Therefore, all champagnes are artificial products." On page 825, of the same volume, it says: " . . . From a chemical standpoint no explanation for the difference (in taste) between the natural and impregnated can be obtained, but we have a reagence in the tongue of experienced wine connoisseurs that will find the difference which cannot be demonstrated chemically." This is a clear proof that not the slightest adulteration was discovered in the impregnated champagne. Strictly taken, the term "champagne" is wrongly applied to all sparkling wines not made in Champagne.

The Clardy bill is nothing else but a protective tariff for the benefit of one protected sparkling wine-producing clan against another legitimate but unprotected inland industry of sparkling wines, merely because made in a different way. The bill is unjust and the measure unconstitutional. All the alleged adulterations of the impregnation are open falsehoods, none of which can be proven, contrary, it is much easier to adulterate the wine in making champagne in bottles and finishing the process in a few weeks, calling it then natural champagne, because made in bottles, than it were possible to adulterate the wine by the new process.

G. K.

San Francisco, June, 1882.

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